AS 1289.6.2.2:2020

Australian STANDARD®

Methods of testing soils for engineering purposes

Method 6.2.2: Soil strength and consolidation tests — Determination of shear strength of a soil — Direct shear test using a shear box

STANDARDS Australia

AS 1289.6.2.2:2020

This Australian Standard® was prepared by CE-009, Testing Of Soils For Engineering Purposes. It was approved on behalf of the Council of Standards Australia on 17 June 2020.

This Standard was published on 26 June 2020.

This Standard was issued in draft form for comment as DR AS 1289.6.2.2:2020.

Keeping Standards up-to-date

Ensure you have the latest versions of our publications and keep up-to-date about Amendments, Rulings, Withdrawals, and new projects by visiting:
www.standards.org.au

ISBN 978 1 76072 911 0

Australian STANDARD®

Methods of testing soils for engineering purposes

Method 6.2.2: Soil strength and consolidation tests — Determination of shear strength of a soil — Direct shear test using a shear box

Originated as AS 1289.6.2.2—1998.
Second edition 2020.

Preface

This Standard was prepared by Standards Australia Committee CE-009, Testing of Soils for Engineering Purposes, to supersede AS 1289.6.2.2—1998.

The objective of this document is to set out a method for performing direct shear (shear box) tests on soils with a wide range of particle sizes. The data recorded from the test method is used to interpret soil strength. Usually three single-stage tests at different normal stresses are applied. The interpretation of the results may then be carried out by a suitably experienced and qualified person, such as a geotechnical engineer.

The major changes in this edition are as follows:

(a) The determination of the apparent cohesion value and the friction angle has been deleted.

(b) Procedures for the preparation of specimens have been updated in light of developments showing sensitivity of test results to sample preparation.

(c) This document encompasses larger shearboxes up to 300 mm.

NOTE In the 1998 edition it was limited to 100 mm.

Contents

NOTES

Australian Standard®

Methods of testing soils for engineering purposes

Method 6.2.2: Soil strength and consolidation tests — Determination of shear strength of a soil — Direct shear test using a shear box

1 Scope

This document sets out a method for determining the effective shear strength of a soil by direct shearing in a shear box. The method specified is for a single-staged test, i.e. with a single value of applied normal stress.

This document applies to shearing of dry, fine-grained and clay soils using shear boxes having shear plane dimensions up to a maximum of 300 mm × 300 mm.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

AS 1289.0, *Methods of testing soils for engineering purposes, Part 0: Definitions and general requirements*

AS 1289.6.6.1, *Methods of testing soils for engineering purposes, Method 6.6.1: Soil strength and consolidation tests — Determination of the one-dimensional consolidation properties of a soil*

AS 1726, *Geotechnical site investigations*

3 Terms and definitions

For the purpose of this document, the definitions below apply.

3.1
may
indicates the existence of an option

3.2
normal
stress is one that occurs when a member is loaded by an axial force

3.3
shall
indicates that a statement is mandatory

3.4
should
indicates a recommendation

4 Principle

A predetermined normal stress is applied under one-dimensional conditions, allowing sufficient time for any consolidation or creep to occur and then shearing the soil by displacing one half of a shear box relative to the other. Interpretation of the shearing stage of the test assumes that the soil is drained and the displacement rate is chosen so that it is slow enough to ensure fully drained behaviour. Shear boxes used allow for either circular or square specimens, with the maximum length of specimen in the direction of shearing varying from 50 mm to 300 mm. Specimens are either tested in their natural (undisturbed) state or can be prepared by remoulding or reconstitution directly in a shear box. Different procedures for different soil types are specified.

5 Apparatus

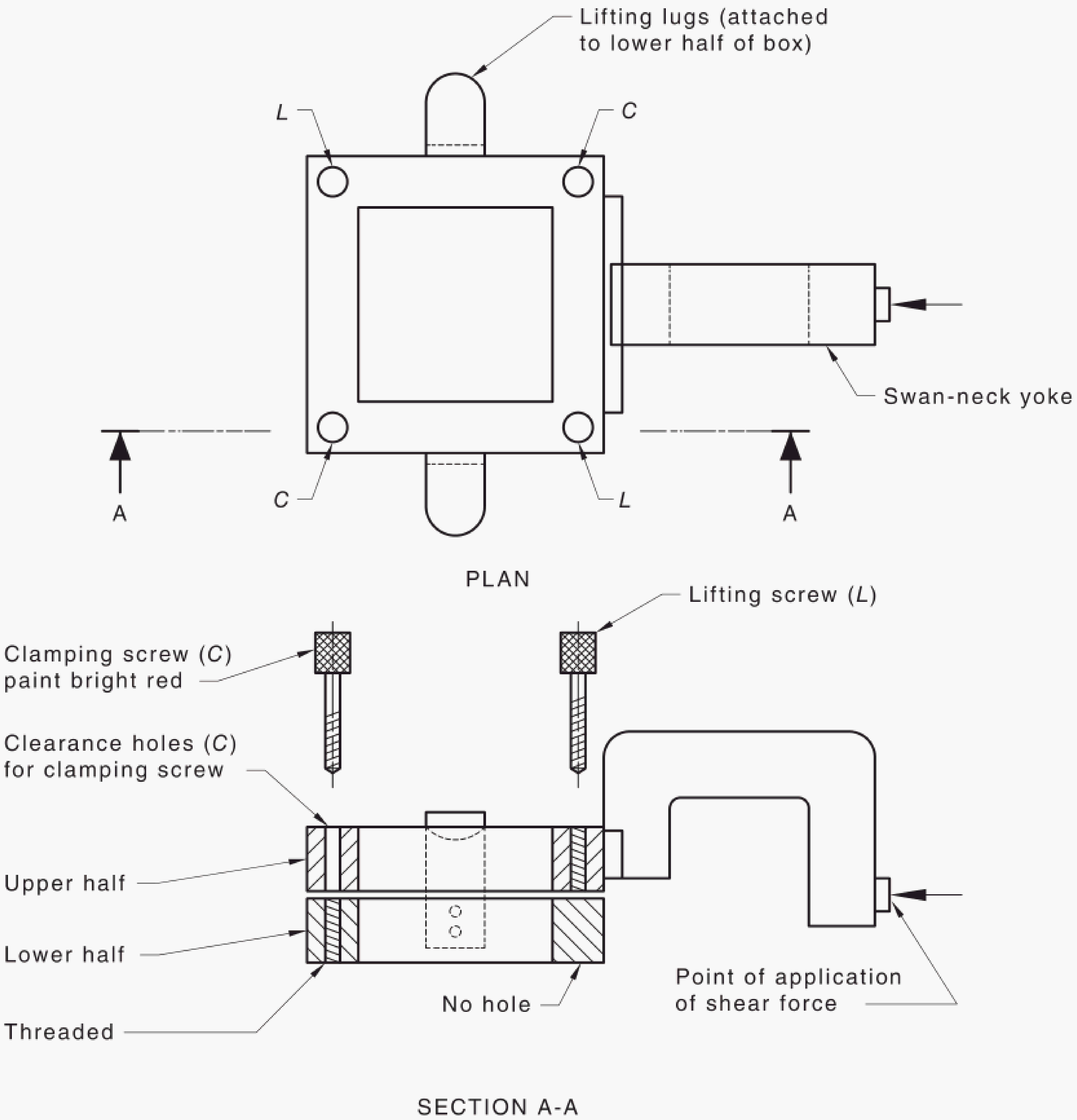
5.1 General

The following apparatus is required:

(a) A shear box consisting of two separate halves which can be moved relative to each other to enable shearing a soil sample along a predetermined plane.

Boxes shall be constructed of non-corrosive material such as brass. The shear box shall be designed so that the soil sample can be subjected to a normal stress applied perpendicular to the plane of shearing. Where drainage is required, the design shall also allow porous plates (these could be either stone, ceramic or sintered bronze) to be placed above and below the soil specimen. The load shall be applied through a loading cap which rests on top of the soil specimen and upper porous plate, if used.

NOTE 1 A schematic design of a typical shear box is shown in Figure 1.



Key

C Holes for clamping screws

L Holes for lifting screws

Figure 1 — Typical schematic design of a shear box

(b) An outer box or carriage (running on ball or roller races) in which the shear box can be placed so that the specimen can be totally submerged in water.

(c) A motorized worm drive unit, capable of pushing or pulling at the level of the shear plane in such a way that the bottom half of the shear box moves relative to the top half.

The speed at which the worm drive shears the soil shall be adjustable, typically by using a gear box, so that a range of shearing speeds can be attained. For soil specimens where consolidation is not rapid, the shearing speeds shall be calculated using the equations given in Clause 6. The selected displacement rate shall not vary by more than ± 10 % during the test.

(d) A loading frame arranged so that the points of load application between the worm drive and the bottom frame and of the reaction between the proving ring (or load cell) and the upper half of the box shall be in the plane of shearing.

(e) A mechanism for applying the normal force, typically a hanger loaded by dead weights, either directly or through a lever system, or a hydraulic/pneumatic loading system.

The load shall be applied centrally to the loading cap through a ball bearing in a spherical seating. The normal load shall remain constant during shearing and be applied with an accuracy of 1 %.

(f) A device for measuring the shear force applied to the specimen.

This device shall consist of a load cell or proving ring providing an accuracy of 1 % of the shear load at failure mounted between the loading frame and the upper half of the shear box, with a gauge or electrical output from which the load can be obtained after calibration.

(g) A device to measure the horizontal displacement of the lower half of the box with respect to the upper half of the box.

If the displacement of the carriage is measured relative to the loading frame, then corrections will need to be made to allow for any compression in the shear force measuring mechanism. The device shall have an allowable travel length of at least 15 % of the specimen length, a resolution of 0.01 mm and be accurate to at least 0.05 mm.

(h) A device to measure the vertical displacement of the loading cap.

The device shall have an allowable travel length of at least 10 % of the sample height, a resolution of 0.001 mm and be accurate to at least 0.005 mm.

(i) A specimen cutter to cut undisturbed specimens of the required shape and size for the shear box.

(j) Trimming equipment such as a wire saw, a spatula or a suitable knife for preparing specimens.

(k) A balance with limit of performance as shown in Table 1.

Table 1 — Balance limit of performance

Sample size g	Limit of performance of balance not greater than g
< 100	±0.05
≥ 100 and < 500	±0.5
≥ 500	±5

(l) Moisture content tins.

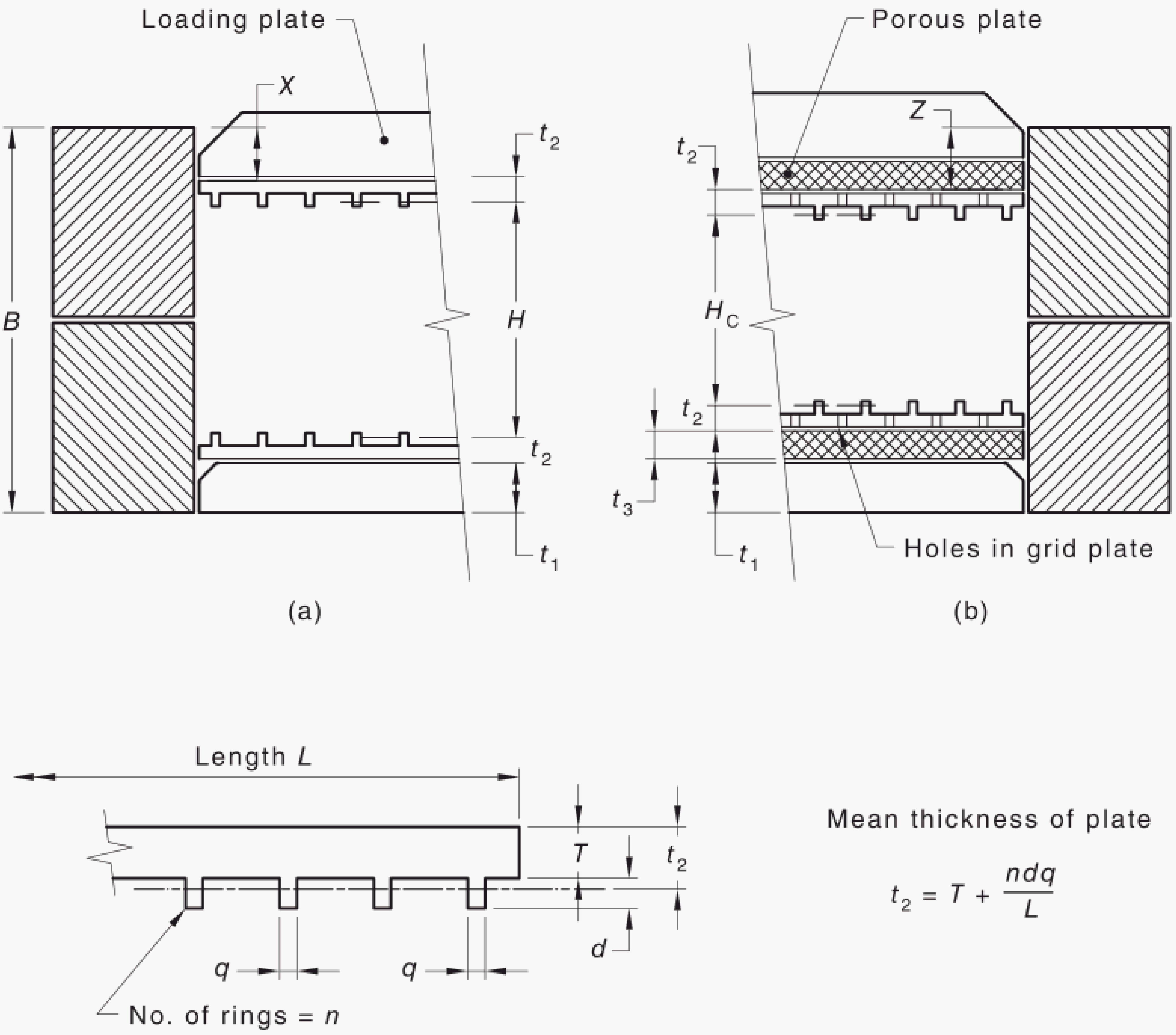
(m) A drying oven in accordance with the requirements of AS 1289.0.

(n) A rule graduated in millimetres and vernier callipers with a precision of 0.1 mm.

(o) Equipment for preparing remoulded specimens, if required.

(p) Grid plates (see Figure 2), to prevent slip on the horizontal boundaries.

(q) Silicone grease of suitable grade to assist with lubricating the shear box.



NOTE 2 For notation specifications, see Clause 5.2.

Figure 2 — Cross-section of shear box showing measurements required to determine the sample thickness

5.2 Preparation of apparatus

The apparatus shall be prepared as follows:

(a) Determine the total mass of the top loading plate, top porous plate (if used) and upper grid plate (if used) to the nearest 1 g. Record the sum of these masses as m_{tp}.

(b) Using vernier callipers, measure the inner length (L), between the sides of the box, and the overall depth (B), of the box to a precision of ± 0.1 mm. Measure the thickness of the base plate (t_1), and the mean thickness of the grid plates (if used) (t_2), to a precision of ± 0.1 mm, see Figure 2. The mean thickness of the grid plates shall be calculated from Equation 5.1:

$$t_2 = T + \frac{ndq}{L} \quad (5.1)$$

where

t_2 = mean thickness of the grid plates, in millimetres

T = thickness of the body of the grid plate, in millimetres

n = number of ribs

d = depth of the ribs

q = thickness of the ribs, in millimetres

L = inner length between the sides of the box, in millimetres

(c) Ensure that the shear box is clean and dry and apply a thin film of silicone grease to the mating surfaces of the box.

(d) Assemble the shear box so that there is no step between the inner sides of the two halves of the box and locate and tighten the locating pins. If the upper box contains separating screws, these screws shall be wound back so as to not protrude before assembling the box.

(e) Position the outer box or carriage in its starting position to allow maximum movement of the shear box. If necessary, release the clamps on the shear load measuring device so that it can move freely to allow the shear box to be placed in the carriage. Place the shear box in position in the carriage ensuring that it sits on the base and clamp the bottom half of the box firmly (using clamping screws or spacer pieces) so that it cannot move relative to the carriage.

If the shear box is to be reversed, suitable connections shall be provided between the worm drive and carriage and between the shear load measuring device and the top half of the shear box.

NOTE 1 For shear boxes that do not have the facility for reversing, a modification example is shown in Figure 3.

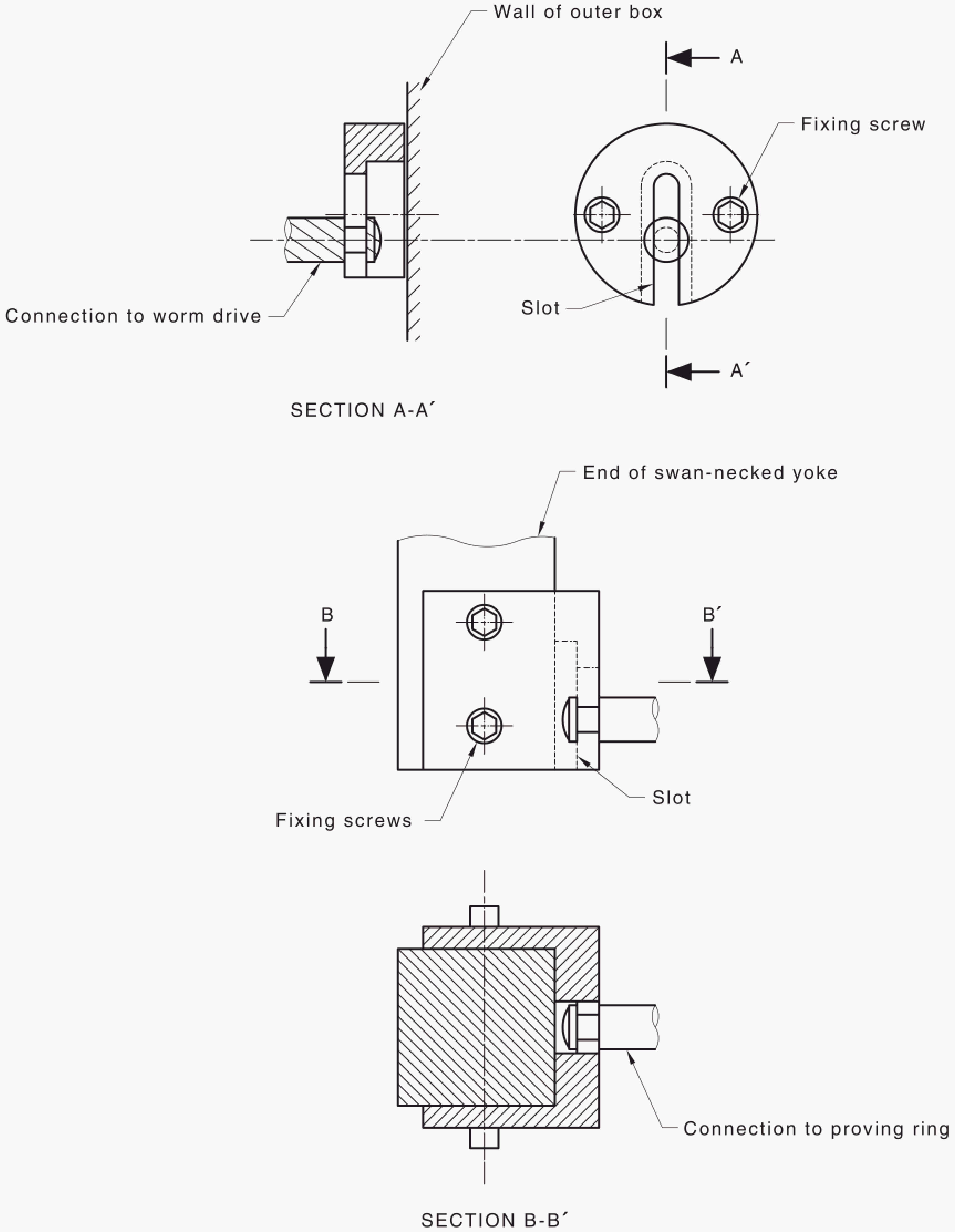


Figure 3 — Example of connections to allow reversing of shear box

(f) Place the lower porous plate, if needed, and the grid plate (if used) with grooves uppermost, into the bottom of the box. The grooves shall be perpendicular to the direction of shear.

(g) Prepare the specimen in the box using the methods for different soil types specified in Clause 6.

(h) Place the upper grid plate (if used), porous plate (if needed) and loading cap on top of the specimen. Ensure that there is a small clearance around the edges of the loading cap and plates.

(i) Adjust the shear load measurement system to ensure there is no shear load and take the zero reading of the device used to measure the shear load. Move the measurement mechanism so that slack is taken up and clamp the measuring system in place, ensuring the load reading remains zero.

NOTE 2 If there is proper contact of the shear box with the proving ring or transducer and no slack in the system, then a small movement of the worm drive should produce a small movement of the proving ring gauge, or reading on the load measuring indicator.

(j) Mount the horizontal displacement gauge or transducer in position, making sure that it has sufficient travel available. Set or record the gauge or linear differential variable transformer (LDVT) zero reading.

(k) Place the hanger carefully onto the top loading plate so that the load is transmitted through the spherical ball seat and the seating arrangement on the hanger.

NOTE 3 Sample compression may occur at this stage as the gauge (or transducer) that measures vertical movement is generally mounted on top of the load hanger. The measuring device may bear on the loading cap for a measure of the initial compression, if needed. If the hanger applies load to the specimen, its mass, m_h, should be measured before placing it.

NOTE 4 For devices with counterweighted hangers that do not apply load, the weight of the hanger is not needed ($m_h = 0$).

(l) Place the vertical displacement gauge or transducer at the centre of the load hanger so that it measures the displacement between the hanger and the loading frame. Ensure that the gauge is set at mid-range to register either an upward or downward movement. Record the initial reading of the gauge.

(m) To minimize the effects of suction for fine-grained soils, where required submerge the specimens by adding water to the carriage so as to maintain the soil in a submerged condition. Check for any vertical movement of the loading cap due to inundation and allow sufficient time for movement to cease.

NOTE 5 For clay soils, swelling under low stress can alter the properties of the specimen. In this instance, ask the client for the recommended normal load at which submerging is to occur. In the absence of such advice, submerging should occur after consolidation is complete at the normal load specified for shearing.

(n) Where required, calculate the mass, m_w, to be placed on the hanger to give the required normal stress, σ_n, from Equation 5.2:

$$m_w = \frac{\sigma_n A}{9810} - m_a \qquad 5.2$$

where

m_w = mass to be placed on the hanger to give the required normal stress, σ_n, in kilograms

σ_n = required normal stress, in kPa

A = cross-sectional area of the specimen, in square millimetres

m_a = mass of the loading cap, plates and hanger ($m_{tp} + m_h$)

Where the load is applied through a lever arm arrangement, the mass to be applied shall be reduced by dividing m_w by the lever arm ratio.

NOTE 6 However, this will depend on the lever arm system and the manufacturer's recommendations should be followed.

Where the load is applied through hydraulic or pneumatic means, the system shall be calibrated to determine the relationship between stress and pressure. In these systems, a load cell shall be used to determine the load transmitted to the top plate.

6 Preparation of specimens

6.1 Specimen requirements

The specimen height shall be between 30 % and 50 % of the specimen length. The heights of the specimen in the two halves of the box should be approximately equal.

The maximum particle size in the soil to be sheared shall be less than or equal to one-tenth of the initial height of the specimen. If the specimen is well graded ($C_u > 6$ and $1 < C_c < 3$), the maximum size shall be less than one-eight of the specimen height.

6.2 Dry soils

Soils that have less than 5 % fines (passing 75 µm) can be tested dry. If the specimen is prepared in layers, the layer boundary shall not coincide with the shear plane, which may form a weak plane.

NOTE The placement method (dry pluviation, use of tamping or vibration) and density of the sand are specified by a suitably experienced and qualified person, such as a geotechnical engineer, requesting the test.

Density or void ratios of dry soil specimens shall be determined as follows:

(a) After the lower plate and grid plate (if used) have been positioned in the base of the box, the dry soil shall be placed to the required density, see below for examples. The mass of soil placed into the box shall be determined by weighing a container plus soil (m_1), before pouring and weighing the remaining soil plus container (m_2), after pouring. Care shall be taken to recover any soil spilled during this process, and to return it to the container for determination of m_2. The mass, m, of soil in the box shall be calculated from Equation 6.1:

$$m = m_1 - m_2 \qquad 6.1$$

where

m = mass of soil contained in box, in grams

m_1 = mass of soil plus container before pouring, in grams

m_2 = mass of soil plus container after pouring, in grams

(b) The upper plate, which may be ribbed, shall be placed on top of the soil and bedded down with minimum pressure. If ribbed, the ribs shall be perpendicular to the direction of shear. After the upper plate has been placed, the distance to ± 0.1 mm from the top of the shear box to the top surface of the upper plate shall be measured. This measurement shall be taken at each of the four corners or mid-points of the sides of the grid block and the values averaged to give the distance (x), see Figure 2. The thickness of the sand specimen shall be calculated from Equation 6.2:

$$H = B - \left(t_1 + 2t_2 + x\right) \qquad 6.2$$

where

H = thickness of the sand specimen, in millimetres

B = overall depth of the box, in millimetres

t_1 = thickness of the base plate, in millimetres

t_2 = mean thickness of the grid plates, in millimetres

x = mean distance from the top of the shear box to the back of the grid plate, in millimetres

If grid plates are not used, the thickness of the sand specimen shall be calculated from Equation 6.3:

$$H = B - (t_1 + t_3 + x) \quad 6.3$$

where

t_3 = thickness of the top plate, in millimetres

Examples of how dry soils of different densities may be prepared are as follows:

(i) *Loose state* — Carefully pour the soil into the shear box from a low height. Level the top surface of the sand with a scraper and below the top of the shear box. Avoid bumping or jolting the shear box in any way, otherwise densification occurs.

(ii) *Medium state* — Compact the material into the shear box in three layers, subjecting each layer to a controlled amount of tamping. Compaction trials may determine how much tamping is needed to produce a required relative density.

(iii) *Dense state* — Carefully pour the soil into the shear box using a high drop, e.g. 450 mm. Vibration of the shear box by tapping with a brass rod or using a vibrating electric engraving tool fitted with a suitable tamping foot can provide additional densification. Vibration under an applied normal load can also aid densification.

6.3 Fine-grained soils

Samples of fine-grained soils shall be prepared as follows:

(a) For undisturbed samples of fine-grained soils, push a cutter having the same internal dimensions as the shearbox specimen into either a block sample or a sample extruded from a large diameter core sampling tube.

NOTE 1 Specimens may also be cut from block samples.

NOTE 2 As commonly used sampling tubes are smaller than 100 mm, circular inserts may need to be used in square shear boxes.

(b) For remoulded samples, compact the sample at the required moisture content directly into the shear box, or compact it into a mould from which a specimen can be cut by using a suitably sized cutter.

(c) For reconstituted samples, place a slurry directly into the shear box, or consolidate the slurry in a mould under a vertical stress sufficient for a cutter to create a specimen that can be placed in the shear box.

(d) After cutting, place porous plates and, if used, grid plates above and below the specimen, see Figure 2(b). The grid plates shall not be used with stiff clays as the ribs may not fully penetrate the soil and interfere with consolidation measurements.

(e) Take two moisture content samples from the cuttings and determine the mean initial moisture content, w_0. The wet mass of the sample, m_c, shall be obtained by weighing the specimen and the cutter and subtracting the weight of the cutter. For the specimen height, H_c, the thickness of the cutter may be measured.

(f) Determine the thickness of the sample, H_c, from the thickness of the cutter, or for samples moulded in the shear box, following the procedure in Item 6.2(b).

(g) Fill the carriage with demineralized/distilled water to submerge the specimen.

NOTE 3 To avoid suctions affecting the test interpretation, all soil specimens with fines should be tested fully submerged.

6.4 Consolidation of specimens

Specimens shall be consolidated as follows:

(a) Apply the pre-determined vertical load carefully to the specimen ensuring no impact occurs.

(b) For dry soils, consolidation will occur rapidly. Record the vertical displacement as soon as practicable after the load is applied. Measure the displacement after 10 min. If the reading is stable the specimen is ready for shearing.

(c) For fine-grained soils, consolidation may occur over a long period of time. Place the specimen in the box and read the vertical displacement gauge, apply a seating load of 5 kPa and allow to consolidate.

When movement has stopped, take the initial reading and apply water and undertake the consolidation readings so as to determine the shearing speed. Take readings of the vertical movement gauge at 15 s, 30 s, 1 min, 2 min, 4 min, 8 min, 16 min, 32 min, 1 h, 2 h, 4 h, 8 h and 24 h or until the compression of the sample ceases as determined by the calculations. Estimate the time for 90 % consolidation from the settlement time response, using the root time plotting method set out in AS 1289.6.6.1.

NOTE For free draining soils, consolidation may occur so rapidly that all settlement is complete before the first reading. In this situation, calculation of t_{90} is unnecessary and the shear rate can be taken as the maximum allowed, 1 mm/min.

(d) Calculate the time to reach failure, t_f, from Equation 6.4:

$$t_f = 12.5 t_{90} \quad (6.4)$$

where

t_f = time taken to reach failure, in minutes

t_{90} = time taken to reach 90 % consolidation, in minutes

(e) Calculate the rate of shearing from the consolidation using Equation 6.5:

$$R = \frac{d_p}{t_f} \quad (6.5)$$

where

R = required shearing rate, in millimetres per minute

The maximum rate shall not exceed 1 mm/min.

d_p = shear displacement at which failure is likely to be reached, in millimetres

t_f = time to reach failure, in minutes

Although soil may reach a peak strength at low displacements, for the purpose of calculating the shear rate, failure shall be taken to occur at the limiting displacement, which is approximately 10% of the shear surface length, L. The shear displacement, d_p (in millimetres), at failure shall be estimated as 0.1 L. The required shearing rate, R, shall be calculated from Equation 6.5.

7 Procedures

7.1 Shearing of specimen in one direction

7.1.1 General

Shearing of the specimen in one direction is used to determine the peak and ultimate strengths.

7.1.2 Procedure

The procedure shall be as follows:

(a) After consolidation is complete, remove the locating pins.

(b) For shear boxes in the range of 50 mm to 100 mm, separate the two box halves by between 0.0 mm and 0.5 mm. For 300 mm shear boxes, separate the two box halves between 0.0 mm and 2.0 mm.

NOTE 1 The gap prevents the normal load being transferred from the loading cap to the bottom half of the box. Provided the loading cap and top plates (if used) do not jam in the upper half of the box, any load transfer should be small. The gap should be as small as practicable to prevent extrusion of soil. It is important not to restrain the top half of the box from vertical movement as this can significantly influence the measured shear force.

(c) Calculate the rate of shearing using Equation 6.5.

(d) Commence the test and at regular intervals of shear displacement, record the reading of the proving ring gauge, or load cell and the vertical movement gauge or LDVT. Initially, record readings at least every 0.1 % of the shear plane length, but the frequency of readings can be reduced as shearing progresses.

NOTE 2 Readings should be frequent enough to clearly define the pre-peak and post peak behaviours.

(e) Take readings until the limit of travel of the shear box is reached.

7.2 Shearing of specimen with repeated reversal of shear direction

7.2.1 General

Shearing of clay soil specimens to large shear displacements greater than those from shearing in one direction shall be used to determine ultimate or residual shear strengths. The sample shall be sheared in the forward direction. The direction of shear shall then be reversed until the shear box is back at the starting point, and the sample sheared forward again. This is repeated until the shear strength of the clay reaches its ultimate or residual value.

7.2.2 Procedure

The procedure shall be as follows:

(a) Prepare and consolidate clay soil specimens as specified in Clause 6.

(b) After consolidation is complete, switch on the motor and take readings as specified in Step (e). Calculate the rate of shearing from Equation 6.5. Shearing shall be slow enough to ensure that excess pore pressures dissipate during shearing.

(c) Plot the shear stress (or the proving ring reading, which is approximately proportional to the shear stress) versus displacement.

NOTE 1 Figure 4 shows typically plotted results.

Alternatively, use the load cell output and the shear displacement transducer output to plot the curve using a computer.

(d) Stop the motor when the limit of travel of the shear box is reached and reverse the direction of shear by running the motor in the reverse direction.

NOTE 2 The reversing speed may be adjusted so that the time for reversing the box back to its initial position is faster than the time taken to reach the peak strength on the first stage of shearing.

(e) During reversal, take load readings from the proving ring, if the ring is calibrated to read tension, or the load transducer. If load readings cannot be taken during reversal, take a vertical dial gauge reading when the shear box is back to its original position.

NOTE 3 The calculation of the residual strength should be made using the shear force measured on the forward cycle. Shear force data on the reverse cycle is for information only.

(f) Re-shear the sample in the original (forward) direction. Plot the proving ring dial gauge reading, or load cell readings, against horizontal displacement.

NOTE 4 An alternative method is to plot the proving ring movement against cumulative horizontal displacement as shown in Figure 4. Plotting may be carried out manually, or using a computer.

(g) Reverse and re-shear in the original direction by repeating Steps (c) to (f) until a constant residual stress is reached, see Figure 4.

NOTE 5 A minimum of 10 cycles of shearing may be required to determine the residual friction angle.

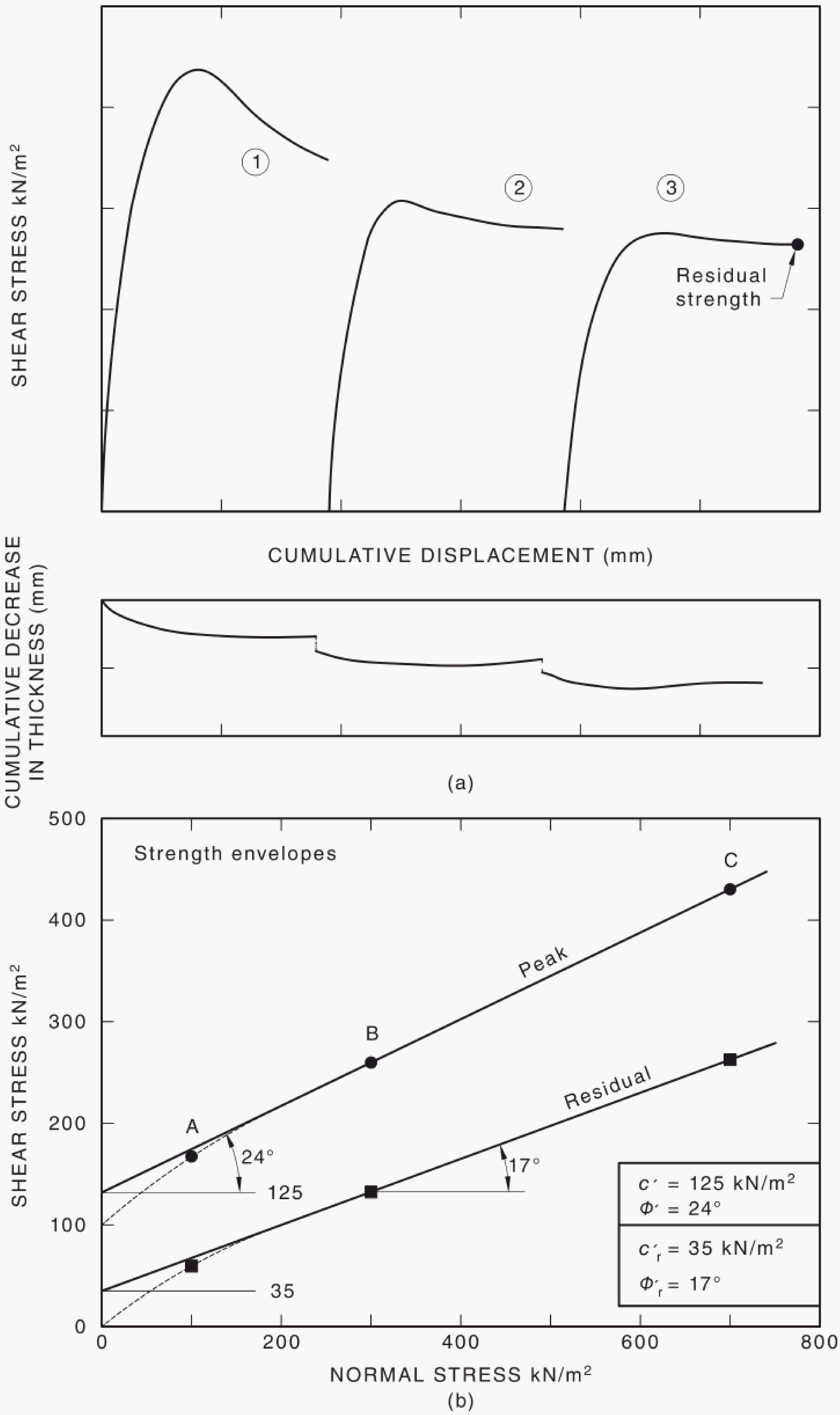


Figure 4 — Typical result for shear box test on clay involving multiple reversals of the shearing direction

7.3 Removal of specimens

Specimens shall be removed as follows:

(a) For dry soils, remove the top grid plate and tip the soil into a dish which has been pre-weighed, brushing out all soil particles from inside the box. Use the mass of soil in the dish to check against the initial mass of soil calculated from Equation 6.1.

(b) For fine-grained soils, remove excess water from around the apparatus before removing the normal load. Then remove the whole sample which shall be used for a moisture content determination.

8 Calculations

The following calculations shall be used:

(a) *Dry soils* — Calculate the density of the soil at the start of shearing, ρ_s, in the shear box from the mass and height of the sample. If the application of the normal stress causes a change in the thickness of the sample of y mm, then the new height shall be $H' = (H - y)$ mm. The density of the soil shall be determined from Equation 8.1:

$$\rho_s = \frac{1000m}{H' \times A} \tag{8.1}$$

where

ρ_s = density of soil in the shear box, in tonnes per cubic metre

m = mass of soil in the shear box, in grams, see Equation 6.1

H' = corrected height of the specimen, in millimetres

A = cross-sectional area of the specimen, in square millimetres.

(b) *Fine-grained soils* — Calculate the initial bulk density of the specimen from Equation 8.2:

$$\rho = \frac{1000m_c}{H_c \times A} \tag{8.2}$$

where

ρ = initial bulk density of the specimen, in tonnes per cubic metre

m_c = mass of sample, in grams

H_c = thickness of the sample, in millimetres, see Equation 6.3

A = area of cross-section of the cutter, in square millimetres

Calculate the initial dry density, ρ_d, from Equation 8.3:

$$\rho_d = \frac{100\rho_c}{100 - w_0} \tag{8.3}$$

where

ρ_d = initial dry density of the specimen, in tonnes per cubic metre

ρ_c = initial bulk density of the specimen, in tonnes per cubic metre

w_0 = initial moisture content of the specimen, as a percentage

(c) *Normal stress* — If Equation 5.2 is used to determine the mass applied to the hanger, the normal stress applied shall be equal to the specified value.

(d) *Shear stress* — Calculate the shear stress, tau (τ) in kPa, from Equation 8.4:

$$\tau = \frac{F \times 1000}{A} \tag{8.4}$$

where

τ = shear stress, in kilo newtons per square metre

F = shear force in newtons

A = initial area of the shear plane, in square millimetres

9 Test report

The following results and general information shall be reported:

(a) *Dry soils*:

(i) Initial dry density of each specimen of soil tested. Initial void ratio may also be reported if the specific gravity of the sand is assumed or known.

(ii) A plot of the vertical displacement versus horizontal displacement for each specimen tested.

(iii) A plot of shear stress versus the horizontal displacement for each specimen tested.

(iv) Values of the ultimate shear strength of the soil in kPa at the limit of travel and applied normal stress.

(v) Values of the peak shear strength of the soil in kPa and applied normal stress (if a peak larger than the ultimate exists).

(b) *Fine-grained soils sheared in one direction*:

(i) Type of specimen (undisturbed, remoulded or reconstituted) and method of preparation.

(ii) Initial water content, w_0, expressed as a percentage for each specimen tested.

(iii) Initial dry density, ρ_d, for each specimen tested, in tonnes per cubic metre.

(iv) Plot of vertical displacement versus the square root of time during specimen consolidation.

(v) A plot of the shear stress versus the shear displacement.

(vi) A plot of the vertical displacement versus horizontal displacement.

(vii) Values of peak and ultimate shear strength of the soil to the nearest kPa.

(c) *Clay soils sheared through repeated reversal of shear direction*:

(i) Type of specimen (undisturbed, remoulded or reconstituted) and method of preparation.

(ii) Initial water content, w_0, for each specimen tested, as a percentage.

(iii) Initial dry density, ρ_d, for each specimen tested, in tonnes per cubic metre.

(iv) Plots of vertical displacement versus the square root of time during specimen consolidation.

(v) A plot of the shear stress versus the shear displacement for each forward shearing stage for each specimen tested.

(vi) A plot of the vertical displacement of the specimen versus the shear displacement for each forward shearing stage.

(d) *General information*:

(i) Project title and client.

(ii) Shearing rate, in millimetres per minute.

(iii) Date of the test.

(iv) Identifying number of the sample (i.e. client's identifying number, laboratory specimen number).

(v) Size of shear box and the specimen height.

(vi) Soil description in accordance with AS 1726:2017 Section 6.

NOTE Refer to the Unified Soil Classification System for further information on soil description.

(vii) Rotation of the top cap, smearing of clay between the box halves, and any twisting or lifting of the top half of the box.

(viii) Reference to this Australian Standard, i.e. AS 1289.6.2.2.

Standards Australia
Standards Australia develops Australian Standards® and other documents of public benefit and national interest. These Standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth Government, Standards Australia is recognized as Australia's peak non-government national standards body.

For further information visit www.standards.org.au

Australian Standards®
Committees of experts from industry, governments, consumers and other relevant sectors prepare Australian Standards. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

International Involvement
Standards Australia is responsible for ensuring the Australian viewpoint is considered in the formulation of International Standards and that the latest international experience is incorporated in national Standards. This role is vital in assisting local industry to compete in international markets. Standards Australia represents Australia at both the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

For information regarding the development of Standards contact:
Standards Australia Limited
GPO Box 476
Sydney NSW 2001
Phone: 02 9237 6000
Email: mail@standards.org.au
www.standards.org.au

ISBN 978 1 76072 911 0