IS 13326 (Part 1) : 1992
(Reaffirmed 1997)

भारतीय मानक

भूकृत्रिम सामग्री तथा मिट्टी के बीच अंतरापृष्ठ घर्षण का मूल्यांकन — परीक्षण पद्धति

भाग 1 रूपान्तरित प्रत्यक्ष अपरूपण तकनीक

Indian Standard

EVALUATION OF INTERFACE FRICTION BETWEEN GEOSYNTHETICS AND SOIL — METHOD OF TEST

PART 1 MODIFIED DIRECT SHEAR TECHNIQUE

UDC 621·13 [677·06] : 620·178·16

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 2

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Geosynthetics Sectional Committee had been approved by the Civil Engineering Division Council.

Coefficient of interface friction between a given soil (including aggregate and ballast) and a geosynthetic (geotextile/geogrid/geomembrane/geocomposite) used for reinforcement purposes is a design parameter in several applications like embankments on soft foundations, road construction, reinforced walls and embankments for slope protection. This coefficient is a function of the nature of the geosynthetic surface, the soil and the normal stress. The total shearing resistance may be a combination of sliding and rolling friction and interlocking of the grains in the geosynthetic. The method of test does not distinguish between the mechanism. For comparison purposes tests shall be performed using the same soil and in the same normal stress range. The tests may be conducted in dry or wet condition.

In all these applications stated above, the geosynthetic is required to carry load, through the friction developed between the soil and geosynthetic. This method of test is also applicable for assessing the friction between a geomembrance and the natural or compacted soil in order to analyse the stability of the canal/reservoir linings.

At present there are two types of test methods for the determination of interface friction between soil and geosynthetic that are in use the world over. These are the modified direct shear test and the pull out test. In the former, the soil is allowed to slide over the geosynthetic and the test is conducted in a manner similar to that of conventional direct shear test. In the second type of test, the geosynthetic is pulled out after it is embedded in soil.

This part deals with the modified direct shear test method.

In the formulation of this standard, assistance have been derived from the following publications:

i) "Geotextile Engineering Manual", published by Federal High Way Administration (FHWA) — 84, Catalog No.PB 86–149457, March 1985.

ii) "Technical Memorandum (Bridges) BE 3/78 Reinforced Earth Retaining Walls and Bridge Abutments for Embankments," issued by Department of Transport, U. K. (1978)

iii) "Test Methods and Physical Properties of Tensar Geogrids" published by Netton Ltd Black Burn, U. K. (1986).

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*).' The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

EVALUATION OF INTERFACE FRICTION BETWEEN GEOSYNTHETICS AND SOIL — METHOD OF TEST

PART 1 MODIFIED DIRECT SHEAR TECHNIQUE

1 SCOPE

1.1 This standard covers the method of determination of the coefficient of interface friction between a soil (including aggregate and ballast) and a geosynthetic be the modified direct shear technique.

2 REFERENCES

2.1 The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
651 : 1991	Standard sand of testing cement — specification
11229 : 1985	Shear box for testing for soils specification
11593 : 1986	Shear box (large) for testing of soils — specification
13321 (Part 1) : 1991	Glossary of terms for geosynthetics: Part 1 Terms used in materials and properties

3 TERMINOLOGY

3.1 Terms and definitions as covered in IS 13321 (Part 1) : 1991 shall apply.

4 APPARATUS

4.1 Apparatus to be used for the test shall conform to IS* (*under preparation*). However shear box conforming to IS 11593 : 1986 may also be used subject to the following modifications.

a) The bottom half of the box should have facility to be made into a solid block by placement of mild steel (chromium plated) spacer 300 × 300 × 75 mm. Once the spacer is placed the top of this half of the box should be plane.

b) Two mild steel strips 350 × 25 × 5 mm which can be clamped into the two outer sides of the bottom half of the shear box by six screws, in order to hold the geosynthetic test fabric securely in the direction of shear.

NOTE — In case the 15 D_{85} of the soil to be tested is less than 60 mm size then the small shear box, i.e. 60 × 60 × 24 mm conforming to IS 11229 : 1985 can be made use of with appropriate modification, as suggested in **4.1** (a) and (b).

4.2 Miscellaneous equipment as required for trimming geosynthetic specimens may be used.

5 SAMPLING

5.1 Number of samples and their location shall be in accordance with the relevant specification. However, in the absence of any stipulation, at least three samples from locations near each end and the centre of the lot under investigation, shall be selected.

All samples shall be cut with a sharp device to minimise revelling, tearing, or undue strain of the sample; marked to show the machine direction; labelled; and stored and handled in such ways as to protect the fabric from damage or deterioration prior to testing.

6 PREPARATION OF SPECIFICATION

6.1 Geosynthetic specimens in the required direction shall be cut large enough to fit loosely over the soil containers with sufficient excess for clamping. Enough specimens shall be cut to provide a new specimen for each test, with a particular normal stress. If the specimens are to be tested wet, they shall be soaked for 24 hours.

6.2 The soil to be used for the test can be the same as is likely to be used in the field. Standard sand conforming to IS 651 : 1991 may also be used.

*Clause **2.2** to **2.7** (except 2·2 (c) of IS 2720 (Part 39/Sec 1) : 1977 (including amendment No. 1) may be referred till such time, an Indian Standard on the apparatus is prepared.

7 PROCEDURE

7.1 The spacer is fitted into the bottom half of the shear box. Then the geosynthetic test specimen is fixed on its top so that the top face of the material is flush with the top edge of the lower half of the box. Geotextile needs to be fixed on two sides whereas geogrid is fixed only on one side opposite to the direction of shearing.

7.2 The top half of the shear box is then assembled and the soil is filled to the required density and the loading plate positioned.

7.3 The shear box is placed in the container carefully.

7.4 The required normal load is then applied. The test is usually conducted at normal stresses of 50, 100 and 200 KPa. The maximum normal stress shall be equal to the maximum vertical pressure in the fill as obtained from the design calculations. Flood the container with water, if wet test is desired.

7.5 The upper half of the box is lifted up slightly to leave a gap of about 1 mm between the two parts of the box.

7.6 The shear strain should be applied using a deformation rate of 0·20 mm/min.

7.7 The shearing is continued until the shearing load becomes essentially constant or until a displacement of 60 mm is reached whichever is larger.

7.8 During the shearing, the shearing loads and vertical deformation shall be measured at regular intervals of shear deformation.

7.9 After the completion of the test, the apparatus is dismantled, the geosynthetic is removed and its condition is observed.

7.10 The test is repeated for all the three normal stress levels.

8 CALCULATIONS

8.1 The results of test may be recorded as shown in Annex A.

For each test, the ratio of the peak shear stress to the corresponding normal stress is calculated. The mean of the three ratios so obtained is reported as the coefficient of interface friction between the fill and the geosynthetic.

9 REPORT

9.1 The following shall be included in the report:

a) Specimen identification;

b) Soil description/identification;

c) Description of test apparatus;

d) Applied normal stress, KPa;

e) Peak shear stress, KPa;

f) Strain at peak shear stress, %;

g) Plots of shear stress versus shear strain at different normal stresses;

h) Plots of maximum shear stress vs normal stress;

j) Plots of vertical deformation vs shear strain at different normal stresses; and

k) Coefficient of interface frictions.

ANNEX A

(*Clause* 8.1)

PROFORMA FOR RECORDING TEST RESULTS

Project..... Location of sample.....

Rate of shear strain..... Sample No.....

Weight of loading frame..... Proving ring No.....

Normal load applied..... Proving ring constant.....

Geosynthetic Specimen Measurements

Dimensions..... Area.....

Colour ..... Thichness.....

Grid aperture..... Trade Mark.....

Direction of shear.....
Machine or cross machine

Soil Specimen Measurements

Dimensions ..... Area of specimen.....

Initial wet mass of specimen..... Volume of specimen.....

Water content..... Final wet mass of specimen.....

Bulk density..... Water content at the shear zone.....

Recording Shear Stage

i) Thickness of specimen.....mm ii) Area of cross-section of specimen.....cm^2

iii) Rate of shearing.....mm/min iv) Normal stress applied.....kg/cm^2

Date and Time	*Shear Displacement Dial Reading*	*Shear Displacement*	*Proving Ring Reading*	*Shear Force*	*Shear Stress*	*Vertical Dial Readings*	*Vertical Displacement*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

Plot—shear stress *versus* shear displacement and find:
a) Maximum shear stress at the peak of curve, and
b) Corresponding shear displacement.

Recording Summary for Results

Test No.	*Normal Stress*	*Shear Stress at Failure*	*Shear Displacement at Failure*	*Initial Water Content*	*Final Water Content*	*Remark*
(1)	(2)	(3)	(4)	(5)	(6)	(7)

Plot—shear stress *versus* normal stress relationship to obtain:
a) Cohesion intercept, and
b) Angle of shearing resistance.

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