

SRI LANKA STANDARD 371:1976
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**SPECIFICATION FOR
TESTING BOND IN
RE-INFORCED CONCRETE
(PULL-OUT TEST)**

BUREAU OF CEYLON STANDARDS

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(PULL-OUT TEST)

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BUREAU OF CEYLON STANDARDS
53, Dharmapala Mawatha,
Colombo 3,
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This Standard does not purport to include all the necessary provisions of a contract.

SRI LANKA STANDARD
SPECIFICATION FOR TESTING BOND IN
REINFORCED CONCRETE
(PULL-OUT TEST)

FOREWORD

This Sri Lanka Standard Specification has been prepared by the Drafting Committee on Steel. It was approved by the Civil Engineering Divisional Committee of the Bureau of Ceylon Standards and was authorised for adoption and publication by the Council of the Bureau on 1976-01-07.

This specification deals with the method for comparison of the bond resistance of different types of reinforcing bars with concrete by a pull-out test. This method may also be used with suitable modifications, if necessary, for comparing different concrete mixes for their bond characteristics with steel reinforcing bars.

The bond strength, or the measure of the effectiveness of the grip between concrete and steel has no standard quantitative definition. In pull-out tests on plain bars, it is often used to mean the maximum load or bond stress that can be developed. With plain bars, the maximum load is not very different from the load at first visible slip, but in the case of a high bond bar, the maximum load may correspond to a large slip which may not in fact be obtained in practice before other

types of failures occur. It is preferable therefore when comparing plain and high bond bars, to determine not only the maximum load but also the load at arbitrary amounts of slip. One such basis of comparison is the load at first slip, which for the purpose of this Clause is defined as a relative movement between steel and concrete of 0.025 mm (0.0010 in) at the free end of the bar in a pull out test.

All values given in this standard are in metric units with the equivalent inch-values, in brackets.

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 observation shall be rounded off in accordance with CS 102 Presentation of numerical values. The number of figures to be retained in the rounded off value shall be the same as that of the specified value in this standard.

In the preparation of this standard, the considerable assistance obtained from the publications of the Indian Standards Institution is gratefully acknowledged.

1 SCOPE

This Sri Lanka Standard covers the method for the comparison of the bond resistance of different types of reinforcing bars with concrete by means of a pull-out test.

2 PREPARATION OF TEST SPECIMENS

2.1 Bars

Loose scale and rust shall be thoroughly removed from the bars by wire brushing and bars inspected to ensure that they are free from grease, paint or other coatings which would affect their bond. The end of the

reinforcing bars on which the stem of the dial gauge is to bear in the test, shall be ground to a reasonably smooth surface normal to the axes of the bars.

2.2 Concrete mix

The comprehensive strength of concrete should be between 21.0 MPa (2.14 kgf/mm², 1.36 tonf/in²) and 27.5 MPa (2.80 kgf/mm², 1.78 tonf/in²) at the time of testing the pullout specimens. The concrete quality should be carefully controlled throughout the series of tests and the mix and cube strength of the concrete recorded.

2.3 Moulding of specimens

The bar should be embedded vertically in, and pass completely through a block of concrete, along its axis. This block should be a 100 mm (3.9 in) cube for bars upto 12 mm (0.5 in) in diameter, a 150 mm (5.9 in) cube for bars over 12 mm (0.5 in) but not more than 25 mm (1.0 in) in diameter and 225 mm (8.9 in) cube for larger bars. The cube should be reinforced with a helix of 6 mm (0.2 in) diameter plain mild steel at 25 mm (1.0 in) pitch such that the outside diameter of the helix is equal to the size of the cube, each end of the helix being welded to the next turn.

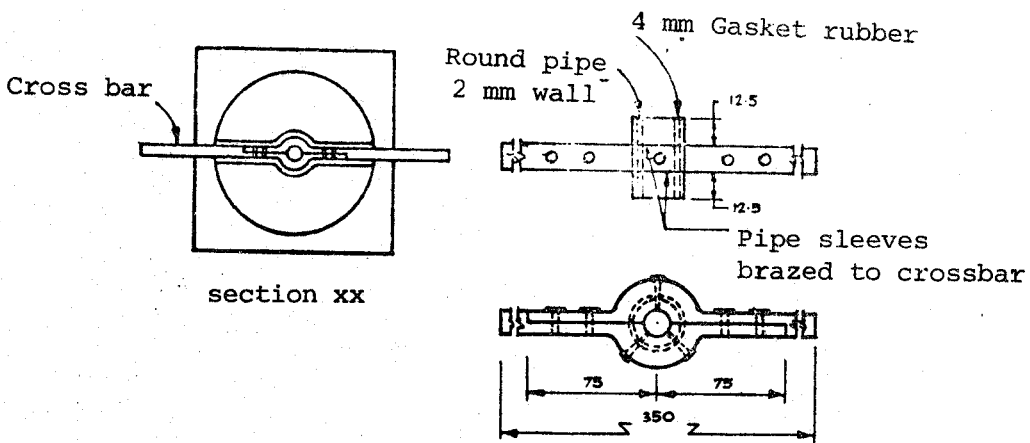
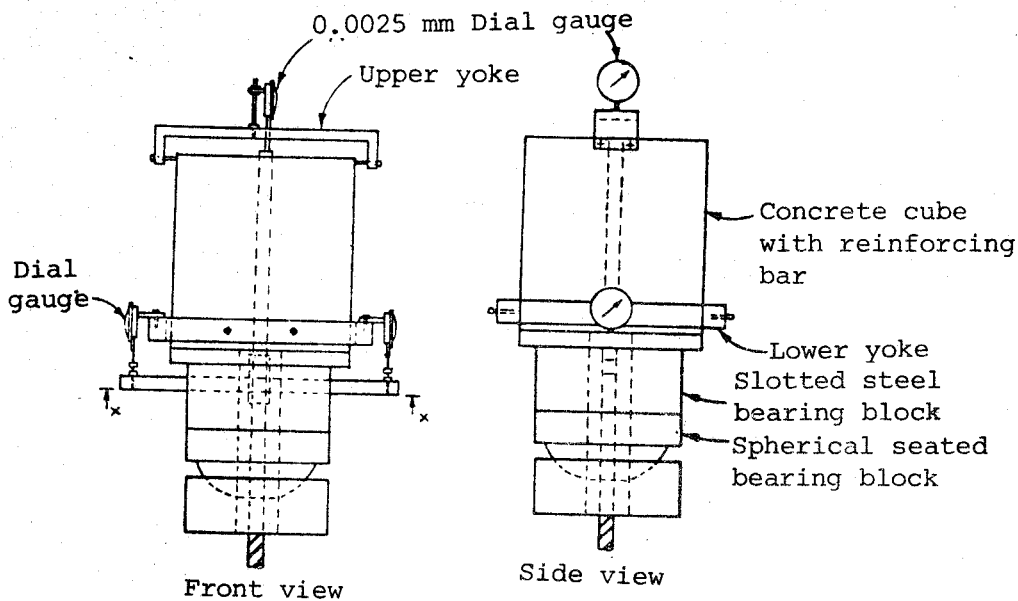
For the purpose of comparing the bond resistance of high bond and plain bars, the concrete used in both tests should be of the same strength, age and curing. The bars to be tested should be of the same nominal diameter.

3 APPARATUS

Apparatus shall be provided for measuring the relative slip between the reinforcing bar and the concrete at both the loaded and unloaded ends of the bar. Dial micrometers shall be used at both locations. At the free end of the bar a dial micrometer graduated to read in 2.5 μ m (0.00010 in) and having a range of not

less than 2.5 mm (0.10 in) shall be used. At the loaded end, dial micrometer graduated in 25 μ m (0.0010 in) and having a range between 12.5 mm (0.49 in) to 25 mm (1.0 in) are desirable.

One type of apparatus that has been found satisfactory is shown in Figure 1. The dial micrometers are mounted on suitable yokes which are attached to the concrete specimen with set screws. At the unloaded end of the bar, the gauge can be adjusted by means of the threaded bolt with which it is attached to the yoke. At the loaded end of the bar, adjustment is accomplished by changing the height of the cap screws on the ends of the cross bar on which the stems of the dial micrometers bear. The split ring cross-bar is attached to the reinforcing bar through four screws in the arms of the cross bar which bring the gasket rubber lining into firm contact with the reinforcing bar. The three set screws as shown are used to ensure additional cross bar contact. The cross bar rests in a slot machined in the intermediate bearing plate. The bearing surface of the concrete cube shall be supported on a square machined steel plate of size not less than the size of the test cube and 20 mm (0.8 in) thick, with a hole of sufficient diameter to accommodate the reinforcing bar drilled through its centre. If a cross bar apparatus as shown in Figure 1 is used this plate should be supported on a steel block at least 125 mm (4.9 in) in diameter and 75 mm (3.0 in) thick. This block should have a central hole to accommodate the reinforcing bar, and also a diametral slot and central hole of dimensions sufficient to accommodate the cross bar on top. This slotted block, in turn, shall rest on a spherically seated bearing block at least 125 mm (4.9 in) diameter having a central hole at least 40 mm (1.6 in) in diameter.



(All dimensions in millimetres)

FIG. Typical measuring and testing apparatus for bend test.

4 TEST PROCEDURE

4.1 The test specimen shall be mounted on a suitable testing machine in such a manner that the bar is pulled axially from the cube. The end of the bar at which the pull is applied shall be that which projects from the top face of the cube as cast.

4.1.1 In assembling the testing apparatus on the specimen the distance between the face of the concrete and the point on the loaded end of the reinforcing bar at which the device for measuring slip is attached, shall be carefully measured so that the elongation of the bar over this distance may be calculated and deducted from the measured slip.

4.2 The load shall be applied to the reinforcing bar at a rate not greater than 2250 kg/min., or at no-load speed of testing machine head of not greater than 1.25 mm/min., (0.49 in) depending on the type of testing machine used and the means provided for ascertaining or controlling speeds.

4.3 The movement between the reinforcing bar and the concrete cube, as indicated by the dial micrometers shall be read at a sufficient number of intervals throughout the test to provide at least 15 readings by the time a slip of 0.25 mm (0.01 in) has occurred at the loaded end of the bar. The dial micrometers shall be read at the loaded and unloaded ends and reading recorded, to an estimated 0.1 of the least division of the dial.

4.3.1 The loading shall be continued and readings of movements recorded at appropriate intervals until:

a) the yield point of the reinforcing bars has been reached,

b) the enclosing concrete has failed (the type of failure shall be noted), or

c) A minimum slippage of 2.5 mm (0.10 in) has occurred at the loaded end.

4.3.1.1 The maximum load for each type of failure shall be recorded.

4.4 For the purpose of comparison the bond resistance of deformed bars and plain bars, the comparison of bond strengths shall be made on the basis of the average bond stresses calculated from the loads at a measured slip of 0.025 mm (0.001 in) at free end. It is recommended that when comparing plain and deformed, the complete load-slip curves of both should also be plotted. The following details shall be recorded:

a) The load at a slip of 0.025 mm (0.001 in) at the free end, and

b) The load at a slip of 0.25 mm (0.01 in) at the free end.

5 CALCULATION OF BOND STRESS

5.1 The slip at the loaded end of the bar shall be calculated as the average of the readings of the 2 dial gauges, corrected for the elongation of the reinforcing bar in the distance between the bearing surface of the concrete block and point on the reinforcing bar at which the measuring device was attached.

NOTE - Theoretically, a similar correction is required, for the compression of the concrete between the bearing surface and the point at which the yoke holding the dials is attached, if the apparatus illustrated in Fig. 1 is used. The movement however, is usually very small and may be neglected.

5.2 For the purpose of this test, the average bond stress shall be the value obtained for each specimen, by dividing the applied load at the slip specified

by the surface area of the embedded length of the bar; and then taking the average value for the group of each type of bar in the test series.

5.2.1 For deformed bars, the surface shall be calculated from the nominal size of the deformed bar as specified in relevant standard specification.

5.3 Number of tests

At least 3 tests should be made on the proposed type of high bond bar and three tests on plain bars for comparison.

6 RECORD OF RESULTS

6.1 The following details shall be recorded:

- a) The crushing strength of the concrete cube at an age corresponding to the age of the specimen at the time of making pull-out tests,
- b) The age of specimen,
- c) The load at a slip of 0.025 mm (0.001 in) at the free end,
- d) The load at a slip of 0.25 mm (0.01 in) at the free end,
- e) The slips at free and loaded ends at regular intervals of loading, and
- f) The maximum load at failure and the type of failure.

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Further particulars of the terms and conditions of the permit may be obtained from the Sri Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 08.



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