

EU TMR network

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“CONFIBRECRETE”

**DEVELOPMENT OF GUIDELINES FOR THE DESIGN OF
CONCRETE STRUCTURES, REINFORCED, PRESTRESSED OR
STRENGTHENED WITH ADVANCED COMPOSITES**



Round Robin Tests

Technical Specifications on Pullout and Splitting Tests

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<http://www.shef.ac.uk/~tmrnet/rrt>

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ROUND ROBIN TESTS

1 Introduction

It is proposed to organise international round robin tests for FRP reinforcement. The aims of this exercise are to:

1. Assist the various international committees working the field of standardization assess the merits of simple tests for material characterization and comparisons
2. Enable comparisons of results between different laboratories
3. Enable simple comparisons between the properties of the different materials that will be tested

Other indirect benefits expected is the familiarization of researchers with the range of FRP products available in the global market and drawing attention to the international affords for development of guidelines and standardisation.

The pull-out test assumes that no concrete splitting will occur and is a measure of the bond strength in confined conditions.

The split test is designed to give a measure of the bond strength that can be obtained in bars near the surface.

None of the above values represents the design bond strength which will be determined by equations given in the design guidelines.

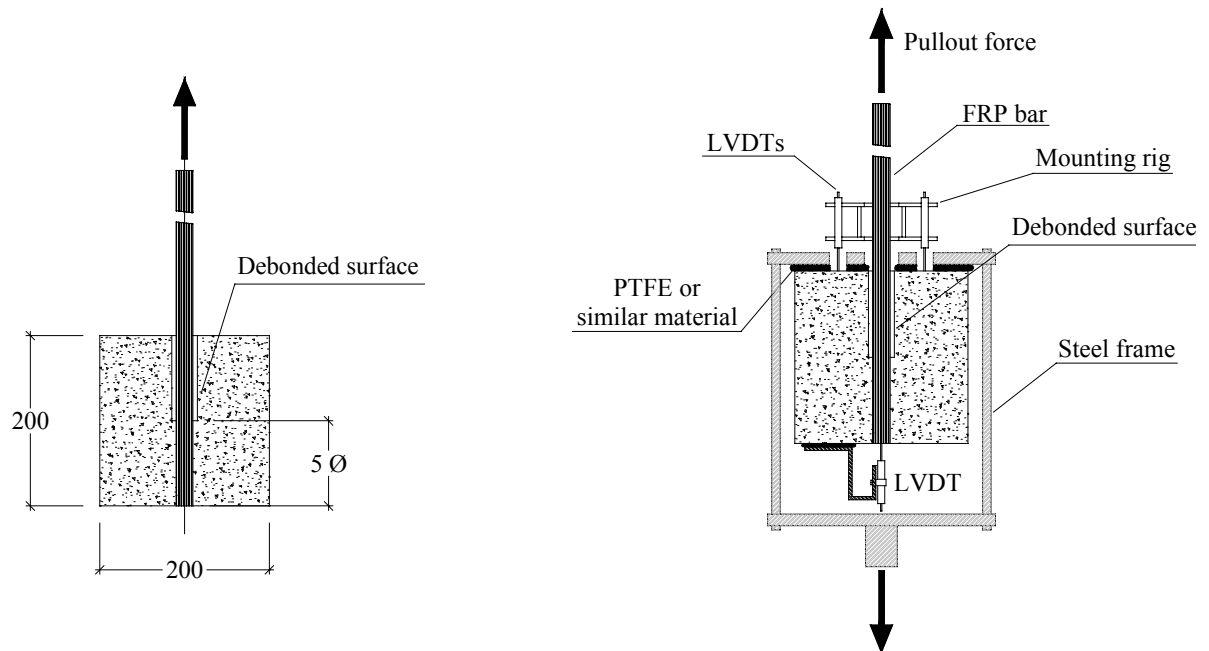
The two simple tests proposed aim to examine the properties of FRP re-bar in bond pull out and split.

The organization of this exercise is undertaken by the “ConFibreCrete” research network working together with the *fib* (International Federation of Concrete) TG 9.3 and ISIS Canada.

All organizational details and results will be posted on this web page and presented to the relevant committees.

2 Pull out test

2.1 Test set-up



Test Set up

Technical notes

1. The details of the loading frame can vary and need to be reported both in a sketch (as shown above) and photographs
2. The reacting plate needs to be stiff enough to avoid deformations
3. The concrete should be cast with the bar in the position as shown in the figure above

2.2 Bar details

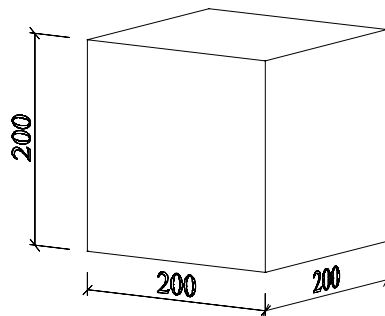
- Maximum bar diameter = 20 mm
- Embedment length = 5 ϕ (diameters)
- The bars will be supplied in 3 samples for each diameter and with a length of 1 meter

Technical notes

1. 200 mm cube is designed to avoid splitting. Hence, the maximum diameter bonded bar is limited to 20 mm.
2. The bonded bar should not project out of the concrete cube to avoid the wedging effect of un-bonded FRP entering the concrete.
3. The bar length is specified as 1 m but can be cut to suit the testing apparatus
4. Three samples are needed to account for material variabilities
5. The embedment length is chosen to be short enough not to develop high stresses in the bars and, hence, no special devices should be needed in the testing machine grip. It is also long enough to be representative of the bar surface deformations

2.3 Concrete

- Concrete cube dimensions = 200 mm or 8"
- Target concrete strength $f_{c(\text{cylinder})} = 40$ MPa
- Days after which the specimen can be tested = > 14 days
- Characteristics of concrete to be reported together with the test data and derived from at least the test of 6 cylinders 150x300 mm (if cubes can be tested, data need to be reported as well)



Standard concrete cube

Technical notes

1. The concrete strength is high enough to cause pull-out damage to the surface of the bar and, hence, not to affect the bond strength significantly
2. The concrete needs to be at least 14 days old before testing to develop the necessary hardness
3. The concrete characteristics should be determined from tests on 6 cylinders tested on the day of pullout. Three further cylinders are to be tested to give the tensile strength according to the Brazilian splitting test. If cubes are used as standard in your laboratory, then the results for cubes should be additional to the above

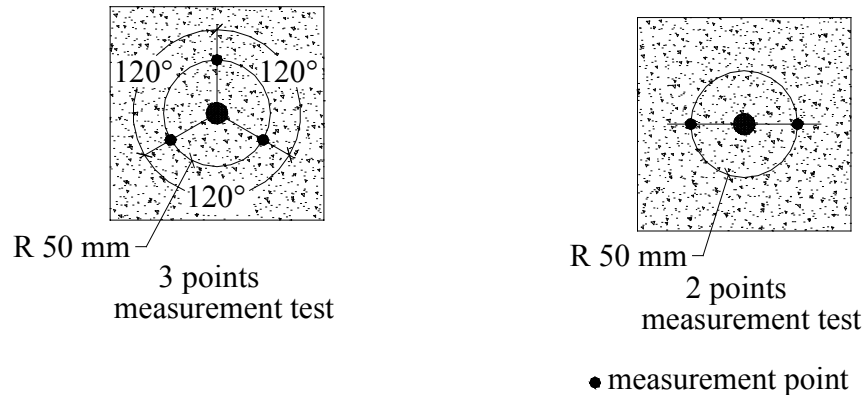
2.4 Other test details

- Loading rate: max 0.1 kN/sec (actual loading rate to be reported)
- Use PTFE or similar material between the reaction area of concrete and test-rig to reduce friction effects

2.5 Measurements

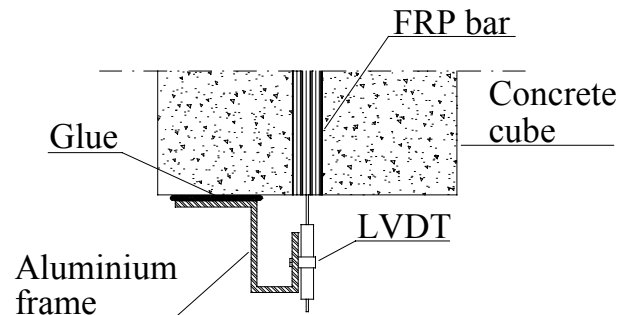
- Loaded end slip

All measurements to be taken preferably following the scheme reported below with two or three transducers



Positioning of LVDTs at the top face of the cube (plan views)

- End slip



LVDT at the bottom face of the cube (vertical section)

Technical notes

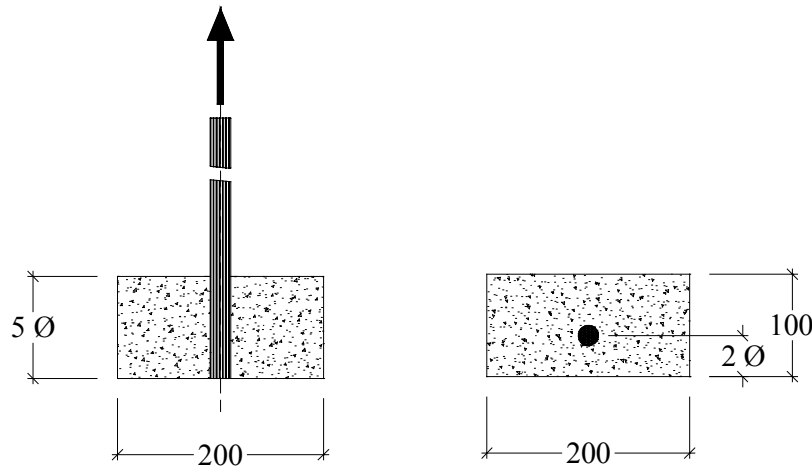
1. End slip can be measured by a single transducer
2. Due to the possibilities of bending, the loaded end slip should be measured by two or three transducers at a distance of 50 mm from the centre
3. The location on the bar at which the transducers are fixed needs to be reported and the elastic extension of the bar needs to be subtracted from the loaded end slip measurements
4. The elastic characteristics of the bar will be supplied by the manufacturers

3 Splitting test

3.1 Test set-up

Same test as above but configuration of the specimen as specified below

- Embedment length = 5ϕ
- Cover = 2ϕ



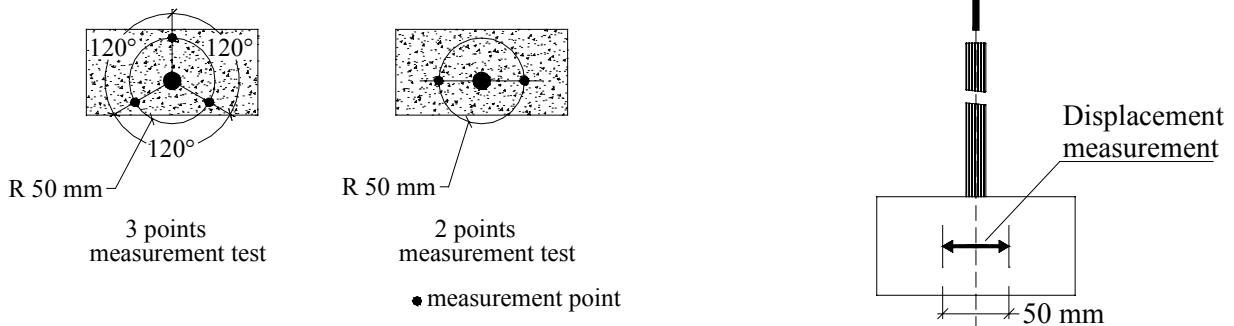
Positioning of the FRP bar for the Split test

Technical notes

1. The same loading frame can be used for both experiments
2. The details of the loading frame can vary and need to be reported both in a sketch and photographs
3. The reacting plate needs to be stiff enough to avoid deformations
4. The concrete should be cast with the bar in the position as shown in the figure above

3.2 Measurements

- End slip (as for Pull out Test)
- Loaded end slip
- Splitting strain to be measured on the surface of specimen



Positioning of strain gauges and LVDTs in Split test

Technical notes

1. End slip can be measured by a single transducer
2. Due to the possibilities of bending, the loaded end slip should be measured by two or three transducers at a distance of 50 mm from the centre
3. The location on the bar at which the transducers are fixed needs to be reported and the elastic extension of the bar needs to be subtracted from the loaded end slip measurements
4. The elastic characteristics of the bar will be supplied by the manufacturers

4 Presentation of results

To be determined. Spreadsheets to be developed etc.



5 Obligations of parties involved

5.1 Manufacturer obligations

1. To supply free of charge* three (or more) samples of 1 meter length of bar for each diameter to all participant laboratories
2. To supply details of the mechanical characteristics for each bar
3. To supply information regarding the handling of the materials

* Laboratories that receive the materials but do not comply with their rules will be asked to refund the suppliers the expenses of materials and shipping

5.2 Testing Laboratory obligations

1. The laboratories agree to undertake the tests as specified by the Round Robin Test organisers
2. The results will be presented in the format specified
3. The results will not be used for any other purposes than for general comparisons during the round robin exercise
4. The results will be made available by the time specified by the organisers of the tests and in no case more than 4 months after receiving all the materials

The laboratories agree to refund all the expenses of bar supply if they fail to meet any of the above requirements