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Test method for tensile properties of
fiber reinforced polymer (FRP) sheets for
reinforcement of concrete

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Land, Infrastructure, Transport and Tourism through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Concrete Institute (JCI) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS A 1191** : 2004), which has been technically revised.

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Test method for tensile properties of fiber reinforced polymer (FRP) sheets for reinforcement of concrete

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 10406-2** : 2015, Edition 2, with some modifications of the technical contents.

The dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA. The comparison table between previous and current editions of this Standard on technically significant revisions is given in Annex JB.

1 Scope

This Standard specifies test methods for tensile properties of fiber reinforced polymer (FRP) sheets for reinforcement of impregnated and cured concrete members using impregnated adhesive resin.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 10406-2 : 2015 *Fibre-reinforced polymer (FRP) reinforcement of concrete — Test methods — Part 2 : FRP sheets* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7721 *Tension/compression testing machines — Calibration and verification of the force-measuring system*

JIS K 7100 *Plastics — Standard atmospheres for conditioning and testing*

JIS Z 8401 *Rounding of numbers*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions, and those given in **JIS K 7100** apply.

3.1

FRP sheet

dry sheet which is impregnated with impregnated adhesive resin and cured, and used for reinforcement of concrete members

3.2

dry sheet

sheet or textile made of bundles which are composed of thousands to tens of thousands of fiber filaments, the diameters of which are a few micrometres to ten and a few micrometres, and which are laid in one direction or two directions on a plane

3.3

impregnated adhesive resin

resin which brings out the function of a complex whose dry sheet is impregnated and cured using impregnated adhesive resin and is combined throughout its fiber filaments, and which has the action of an FRP sheet bonding to the surface of concrete

3.4

anchoring portion

end parts of a test piece where tab is bonded

3.5

tab

plate made of fiber reinforced plastic, aluminium, or any other suitable material bonded to the end part of test piece to transmit loads

3.6

plate

FRP sheet impregnated with resin from which the test pieces are cut

3.7

maximum tensile force

maximum load obtained by the testing machine until the test piece is broken

3.8

ultimate strain

strain corresponding to the maximum tensile force

3.9

fiber bundle

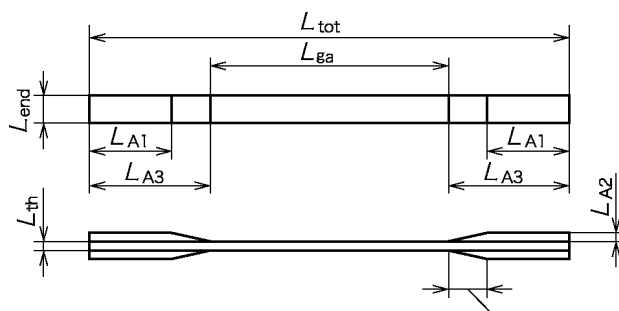
several fiber filaments bound together to form a bundle

4 Test pieces

4.1 Types of test pieces

Two types of test pieces may be used.

- a) **Type A test pieces** Prepare Type A test pieces in accordance with the method described in 4.2 a). The shape and the dimensions of Type A test pieces are given in Figure 1.
- b) **Type B test pieces** Prepare Type B test pieces in accordance with the method described in 4.2 b). These test pieces are suitable for FRP sheets in which the fiber bundles consist of a number of filaments that can be easily separated into individual bundles. The shape and the dimensions of Type B test pieces are given in Figure 1.



The length of tapered part should preferably be about 15 mm.

Unit: mm			
Symbol	Dimension	Type A test piece	Type B test piece
L_{tot}	Total length	≥ 200	
L_{end}	Width at both ends	12.5 ± 0.5	10 to 15
L_{th}	Thickness	Recommended not to exceed 2.5	
L_{ga}	Testing part length	≥ 100	
L_{A1}	Tab grip length	≥ 35	
L_{A2}	Tab thickness	1 to 2	
L_{A3}	Anchorage length	≥ 50	
When the peeling off at tabs and the pull-out in the chuck do not occur, the thickness of the test piece L_{th} can exceed 2.5 mm. When the thickness of the test piece L_{th} is not more than 2.5 mm and fracture at anchoring portion occurs, the specification of the anchoring portion shall be reconsidered.			

Figure 1 Shape and dimensions of test pieces

4.2 Preparation of test pieces

Test pieces shall be prepared in the room at a temperature of 5 °C to 35 °C according to the following method.

a) Type A test pieces

- 1) Prepare a dry sheet cut to a sufficient length considering dimensions of the test piece to be prepared.

- 2) Apply the bottom coat of impregnated adhesive resin to the separation film, attach the aforementioned dry sheet onto the film, and degas while impregnating with impregnated adhesive resin so that the fiber axis of the sheet is in a straight line. Apply the top coat of impregnated adhesive resin and degas again.

The separation film may be of any material to which impregnated adhesive resin used to form a plate does not adhere after curing. Usually the polyester film or polyethylene film is used.

- 3) Apply the additional top coat of impregnated adhesive resin, if necessary, for the purpose of making the plate surface free from dents and bubbles. Smooth the surface applying a suitable pressure so that the thickness of the impregnated adhesive resin layer is even, to form a plate. Covering with separation film and smoothing would be best.
- 4) Cure the plate for the prescribed duration considering manufacturer's instructions, then cut in widths of $12.5 \text{ mm} \pm 0.5 \text{ mm}$. The cut length shall be at least 200 mm. Use e.g. a diamond cutter for cutting.
- 5) Attach the tabs to the end parts of test pieces to form the anchoring portions. When fiber reinforced plastic is used as a tab, the test piece may be cut out after being fixed to the plate.
- 6) Prior to testing, the test pieces shall be conditioned as prescribed in 4.5 considering manufacturer's instructions.

b) Type B test pieces

- 1) Prepare a dry sheet cut to a sufficient length considering dimensions of the test piece to be prepared. Fasten the dry sheet so that the fiber axis is in a straight line.
- 2) In the centre of the fastened dry sheet, mark two straight lines X_1 , X_2 perpendicular to the fiber axis of the dry sheet that define a length of at least 200 mm as shown in Figure 2. Mark two other straight lines approximately 100 mm on either side of the area.
- 3) Working along the fiber axis in the range from X_1 to X_2 , remove one to three fiber bundles from each side of the test piece sections so that the number of fiber bundles that are to be the test pieces becomes at least 5. The width measures 10 mm to 15 mm.

When preparing several test pieces from the same FRP sheet, the portions to be used as test pieces shall be separated by intervals of at least 50 mm in the direction perpendicular to the fiber axis as shown in Figure 2.

- 4) Apply the bottom coat of impregnated adhesive resin to the separation film, attach the aforementioned dry sheet onto the film, and degas while impregnating with impregnated adhesive resin so that the fiber axis of the sheet is in a straight line. Apply the top coat of impregnated adhesive resin and degas again.
- 5) Apply the additional top coat of impregnated adhesive resin, if necessary, for the

purpose of making the plate surface free from dents and bubbles. Smooth the surface applying a suitable pressure so that the thickness of the impregnated adhesive resin layer is even, to form a plate. Covering with separation film and smoothing would be best.

- 6) Cure the plate for the prescribed duration considering manufacturer's instructions, then cut in widths of 10 mm to 15 mm. The cut length shall be at least 200 mm. Use e.g. a diamond cutter for cutting.
- 7) Attach the tabs to the anchoring portions to form the test pieces.
- 8) Prior to testing, the test pieces shall be conditioned as prescribed in 4.5 considering manufacturer's instructions.

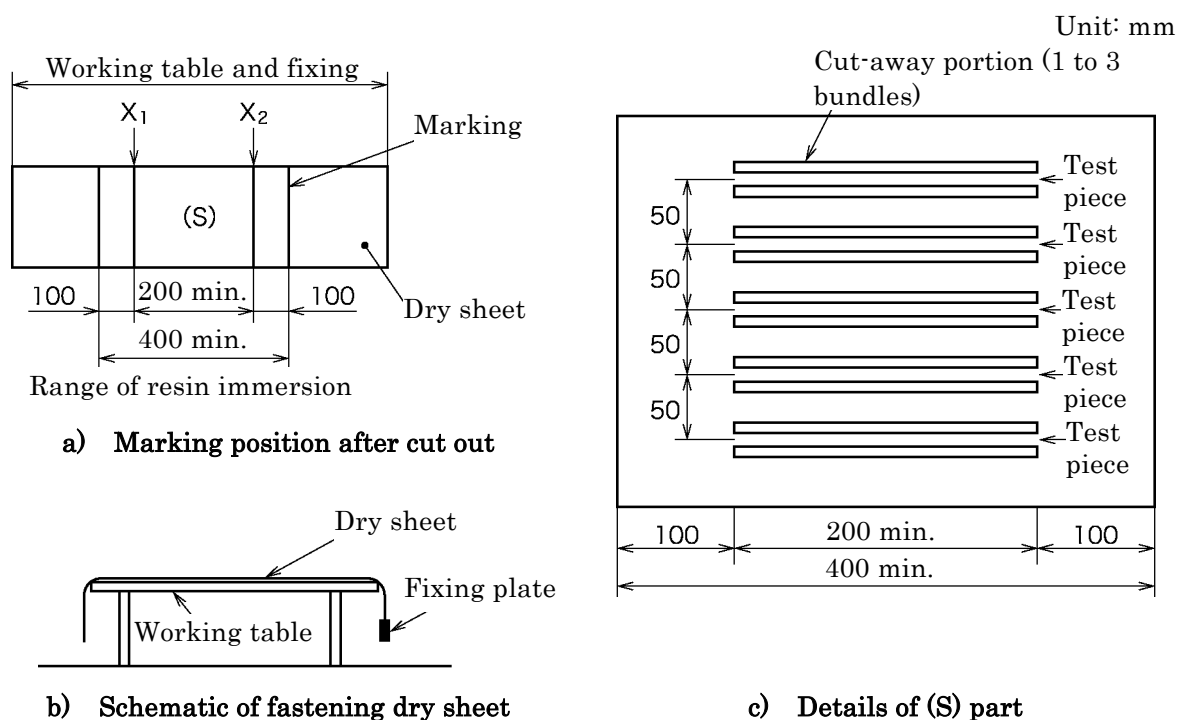


Figure 2 Plate used to prepare Type B test pieces

4.3 Curing of test pieces

Establish the curing period needed to give the test piece the desired strength and cure the test piece considering manufacturer's instructions.

Although the general curing period and the curing temperature are 7 days and 5 °C to 35 °C, respectively, they may be changed taking the working conditions and use environment of the FRP sheets into consideration when the sheets are used under special working conditions and use environment.

4.4 Anchoring portion of test pieces

The anchoring portion of the test piece shall not have a shape that causes the test piece to twist or bend. A tab made of fiber reinforced plastic or aluminium shall be at-