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Application News

No. i282

Hydraulic Universal Testing Machine

Tensile Test of Steel for the Reinforcement of Concrete

Reinforced concrete is a general material in the construction and civil engineering fields, and is used in all types of structures, including buildings, tunnels, and bridges. The ribbed bars used as reinforcing materials for reinforced concrete have a shape with surface rib, which improve bonding with concrete or mortar by providing a larger surface area than that of round steel bars with a smooth surface, and also strengthen resistance against pull-out (slipping). Strength evaluation is important because standard values for tensile strength, proof strength, and other mechanical properties are specified depending on the type of ribbed bar.

Tensile testing method for ribbed bars is described in JIS G 3112 : 2010 "Steel bars for concrete reinforcement." However, measurement in accordance with JIS G 3112 is difficult with the contact-type extensometers in general use, which have a fixed gauge length, because the standard requires that the gauge length of test pieces must be changed depending on the designation (diameter) of ribbed bars. Here, JIS G 3112: 2010-compliant tensile tests of ribbed bars with two different designations were conducted using a Shimadzu TRViewX non-contact digital video extensometer, which enables free selection of the gauge length.

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Measurement System

The instruments used in these tests were a Shimadzu UH-F500kNXh hydraulic universal testing machine and TRViewX 500D2 extensometer, which enables free selection of the gauge length. Table 1 shows the instruments used in the tests, and Fig. 1 shows the condition of the test.

Table 1 Test Instruments

Testing machine	: UH-F500kNXh
Grip	: Grip teeth for ribbed bars
Extensometer	: TRViewX 500D2
Software	: TRAPEZIUM™ X-V single

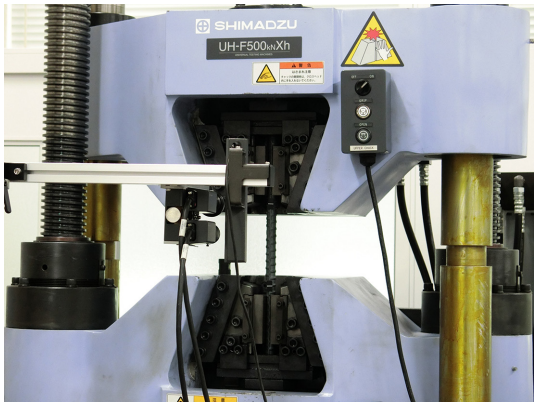

Fig. 1 Condition of Test

Measurement Conditions

The tensile testing method in JIS G3112 is described in JIS Z 2241. A JIS Z 2241 test piece of type 2 is used when the dimensions of a ribbed bar are less than designation D25, and a No. 14A test piece is used with D25 or larger. Here, the gauge length and parallel length are calculated from the values of the nominal diameter in Table 4 of JIS G 3112, and the nominal cross sections in JIS G 3112 are used for the cross-sectional area when obtaining proof stress and tensile strength. Table 2 shows the parallel length and gauge length of the respective test pieces, and Table 3 shows the test information.

Table 2 Test Conditions

Test piece type	Parallel length L_c	Gauge length L_0
No. 2	L_0+2d_0	$8d_0$
No. 14A	$5.5d_0$ -$7d_0$	$5.65\sqrt{S_0}$

* d_0: nominal diameter, S_0: nominal cross-sectional area

Table 3 Test Information

Test strain rate	: V1 Stress rate 10 MPa/s V2 Estimated strain rate 5 %/min V3 Estimated strain rate 30 %/min
Designation of ribbed bar	: D13, D19
Gauge length	: D13 101.6 mm D19 152.8 mm
Gripping distance	: D13 127 mm D19 191 mm
Number of tests	: n = 2

Measurement Results

Fig. 2 shows the stress-strain curves, and Table 4 lists the test results. Average values of the tensile strength, upper yield point, and Young's modulus of the designation D13 ribbed bar used here were 579.6 MPa, 387.5 MPa, and 197.0 GPa, respectively, while the test results for the D19 ribbed bar were 509.2 MPa, 360.1 MPa, and 204.6 GPa, respectively.

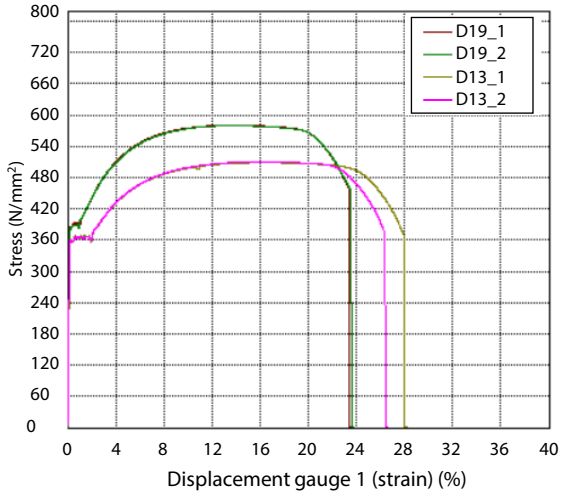

Fig. 2 Stress-Strain Curves

Table 4 Test Results

Test piece	Tensile strength [MPa]	Upper yield point [MPa]	Young's modulus [GPa]
D13_1	580.0	385.1	199.4
D13_2	570.1	389.9	194.7
Average of D13	579.6	387.5	197.0
D19_1	508.5	361.4	199.2
D19_2	510.0	358.7	210.0
Average of D19	509.2	360.1	204.6

Conclusion

This article introduced an example of tensile test of ribbed bars in accordance with JIS G 3112 : 2010. Because the gauge length of the test pieces differs depending on the designation (diameter) of ribbed bars, the TRViewX, which enables free selection of the gauge length, is a suitable extensometer for testing compliant with this standard.

Satisfactory tensile tests of ribbed bars are possible, even when testing bars with mixed designations, by using a Shimadzu UH-X/FX series hydraulic universal testing machine in combination with the TRViewX non-contact digital video extensometer.

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