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Application News

High speed tensile testing machine HITS™-TX

High Speed Tensile Test of High-Strength Steel

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User Benefits

- High speed tests of high-strength steel
- Evaluation of the tensile strength-strain rate relationship of the materials

■ Introduction

High-strength steels (HSS) provide better mechanical properties than conventional structural steels and are widely employed in the automotive field. In fact, HSS high specific strength (tensile strength divided by density) plays a key role in the weight reduction of car parts, greatly contributing to the reduction of CO_2 emissions.

One of the basic mechanical properties of the materials is the tensile strength, and can be measured with a conventional static tensile test (low speed). However, since the tensile strength of HSS increases with the strain rate[1)2)], the tensile strength value obtained with a static test might not be suitable for an accurate component design. For such reason, in order to guarantee a safe and efficient design of automobile parts that may undergo impacts (high speed loads), high speed tests must be conducted to investigate the relationship between the material tensile strength and the strain rate.

In this work, the tensile strength-strain rate relationship has been evaluated with tensile tests at a speed ranging from 0.0001 m/s to 5 m/s. Grip teeth featuring a pin allowed to conduct the tests without slippage. The results showed that tensile strength at high speed is 10% higher than the one measured at low speed.

■ Test Method

The tests were conducted on specimens made of SPFC980 HSS. The size and shape of the specimen are shown in Fig. 1. In case of materials with high hardness such as the SPFC980, standard grip teeth might not ensure a correct clamping, resulting in the slippage of the specimen. To prevent this from happening, a hole was machined in the specimen grip section, and grip teeth featuring a pin were used to clamp the specimen. The test conditions and the details of the test equipment are shown in table 1. For this test, the high-speed tensile testing machine HITS-TX was employed (Fig. 2). HITS-TX is a hydraulic driven testing machine which allows to conduct tests at speeds in a range of 0.0001~20 m/s.

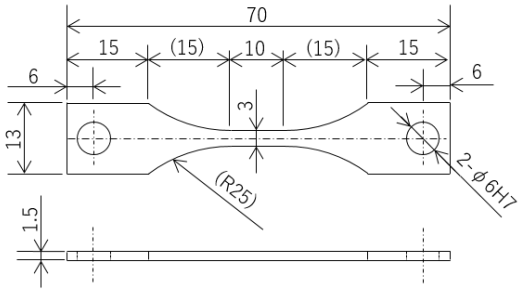

Fig. 1 Specimen Shape and Size (Dimensions in mm)

Table 1 Test Conditions and Details of the Test Equipment

Testing Machine	High speed tensile testing machine HITS-TX
Load Cell	10 kN
Test Speed	0.01, 0.1, 1, 10, 100, 300, 500 s^{-1} (0.0001~5 m/s)
Number of Samples	n = 3
Grips	High-speed grip for flat plate samples
Grip Teeth	File teeth (with pin)
Software	TRAPEZIUM™ HITS

Fig. 2 High Speed Tensile Testing Machine HITS™-TX

■ Test Results

A picture of the test is shown in Fig. 3. The test results concerning the strain rates 1, 10, 100 s^{-1} are here used as representative data to show the relationship between stress and stroke (Fig. 4). The mean value of the tensile strength for each test speed is represented in Fig. 5, and the numerical values are listed in Table 2. From the results it can be seen that the tensile strength at 500 s^{-1} is 10% higher than the one of the specimens tested at 0.01 s^{-1}.

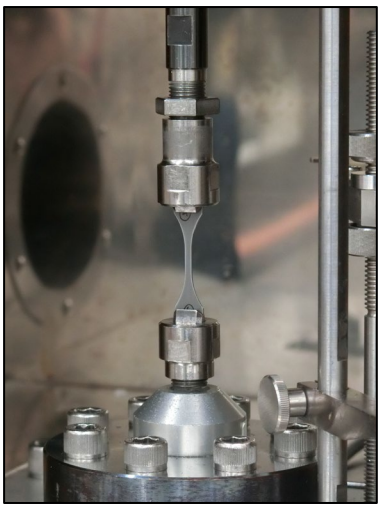

Fig. 3 High Speed Tensile Test

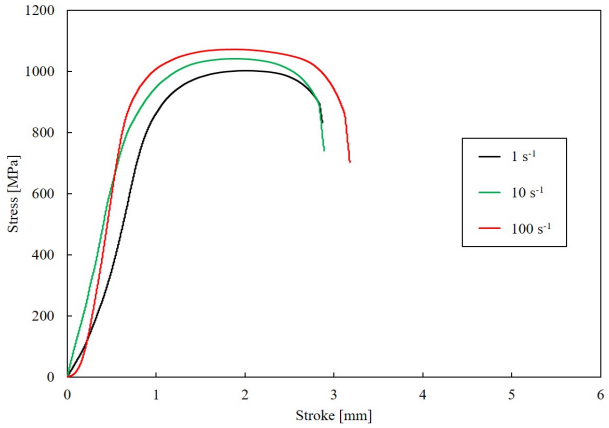

Fig. 4 Stress-Stroke Relationship (Representative cases)

■ Conclusion

In this work, HSS specimens have been tested with the HITS-TX system and the relationship between tensile strength and strain rate could be verified. Furthermore, the grip teeth featuring a pin used in this test allowed to conduct the test without slippage.

In the light of the results obtained in this work, it can be concluded that the HITS-TX system represent a suitable tool to investigate the relationship between properties such as tensile test and the strain rate.

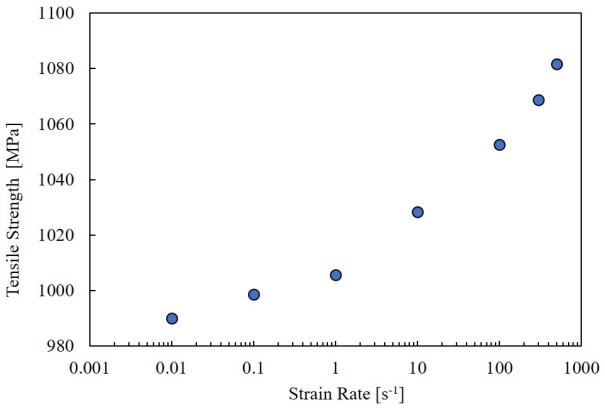

Fig. 5 Tensile Strength-Strain Rate Relationship (Mean Value)

Table 2 Test Results (Mean Value)

Strain Rate s^{-1}	Tensile Strength MPa
0.01	990
0.1	999
1	1006
10	1028
100	1053
300	1069
500	1082

References

1) E. Cadoni, D. Forni, J CONSTR STEEL RES, 175, 106348
2) X. Yang, H. Yang, Z. Lai, S. Zhang, J CONSTR STEEL RES, 168, 105961

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