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Test Method of Forming Limit Diagram of Automotive Sheets (English Translation)

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Foreword

This standard draws on the characteristics of existing automotive sheet forming performance test methods at home and abroad, and has accumulated a large number of tests through special research.

On the basis of data and experience, in accordance with GB/T 1.1-2000 "Standardization Work Guidelines Part I. Standard Structure and Writing Rules" Request for development. In order to meet the test requirements, this standard has the following modifications compared with the current national standard.

- 1) Optimize the sample size according to the forming limit diagram characteristics;
- 2) According to the material thickness and strength level, a detailed test lubrication scheme is recommended;
- 3) Propose the sampling direction requirement of the sample and give a quick determination method;
- 4) According to the development of strain test technology and the need to further improve the test accuracy, a new test data acquisition and processing method is proposed.

law.

This technical standard is one of the technical standards for steel materials of the China

Automotive Engineering Society.

This technical standard was proposed by the Materials Branch of the China Automotive Engineering Society.

This technical standard is approved by the China Automotive Engineering Society.

This technical standard is under the jurisdiction of the China Automotive Engineering Society.

This technical standard was drafted. China Automotive Engineering Research Institute Co., Ltd., Maanshan Iron and Steel Co., Ltd., Wuhan Iron and Steel (set Group) company.

1 Scope

This standard specifies the laboratory measurement method for the forming limit diagram (FLD) of automotive sheets at room temperature.

This standard is applicable to automotive sheets with a thickness of 0.3mm to 3.0mm.

2 Normative references

The terms in the following documents become the terms of this standard by reference to this standard.

GB/T 15825.2-2008 Sheet metal forming performance and test methods - Part 2. General test procedures Sheet metal sheets -- Determination of forming properties and test methods - Part 8 . Guide to forming limit diagrams (FLD) GB/T 24171.2-2009 Determination of sheet metal and sheet strip forming limit curves - Part 2 Determination

3 Symbols, names and units

The symbols, names and units used in this standard are shown in Table 1.

Table 1 Symbols, names and units

Symbolic name unit

FLD forming limit diagram -FLC forming limit curve -Dd die inner diameter mm Dp punch diameter mm Db pad middle hole diameter mm Rd die radius phi Rp punch ball nose radius mm E1, epsilon2 engineering main strain, secondary strain -E1, e2 true principal strain, secondary strain -D0 strain analysis graphic initial size mm D1 strain analysis after deformation, large deformation direction dimension mm D2 strain analysis after deformation, small deformation direction dimension mm

4 Test principle and method

4.1

The forming limit diagram characterizes the degree of ultimate deformation that a sheet can achieve under different near linear paths during deformation. By printing a certain map the sample of the case is bulged to obtain the in-plane strain distribution (ie, the primary strain and the secondary strain) at the limit point before the necking failure, to the lower end of the different strain paths.

The curve drawn by the in-plane strain of the limit point is the forming limit curve. Hemispherical rigid punches can be used when testing the forming limit curve the bulging test is carried out by the bulging method or the cylindrical rigid male bulging method. The forming limit curves obtained by the two bulging modes cannot be used for comparison.

of. Under laboratory conditions, it is recommended to use the hemispherical rigid male bulging method preferentially.

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a) hemispherical rigid male bulging method b) cylindrical rigid male bulging method

Figure 1 Forming limit curve bulging method

4.2

When the hemispherical rigid male bulge test is carried out, a sample with a pattern printed on one side of the plate is placed between the concave die and the bead ring, and the test is pressed with a bead ring.

kind. The specimen is bulged by the punch to form a convex hull, and the pattern on the sample is also changed, and the neck is locally deformed on the convex hull.

Or when rupturing, stop the test, determine the limit point according to the neck or the rupture site (or near these parts), and then according to the pattern printed on the sample the change condition measures and calculates the in-plane strain of the limit point, which is the ultimate strain of the limit point in the bulging state, the ultimate strain Also known as in-plane ultimate strain.

Note: The in-plane ultimate strain can be expressed by the engineering principal strain (ϵ_1 , ϵ_2) and can also be expressed by the true principal strain (e_1 , e_2).

Fig. 2 Internal ultimate strain under different strain paths in the forming limit curve

4.3

The complete forming limit curve generally consists of five strain paths. uniaxial tension, general tensile, plane strain, general bulging and equal bidirectional bulging.

The in-plane ultimate strain of the lower limit point is obtained by using the following method

to obtain the in-plane ultimate strain at different strain paths.

a) Use different width specimens. In general, the larger the difference in the width of the specimen, the greater the difference in the in-plane ultimate strain of the obtained limit points.

Selecting more width specifications is beneficial to obtain the ultimate strain under various strain paths. If the sample width is appropriate, the approximation can also be obtained separately the ultimate strain point of a uniaxial tensile stress state or an approximate plane strain state;

b) Change the lubrication or contact conditions between the sample and the punch. Generally, the difference in the lubrication effect of different lubrication conditions is greater.

The difference in the numerical value of the ultimate strain is greater. In order to test a sufficient ultimate strain point, a certain amount of lubrication conditions should be appropriately selected. If necessary, a rubber (or rubber) thin pad of a suitable thickness may be placed between the sample and the punch to change the contact condition between the mold and the sample.

Obtaining the ultimate strain of the double tensile or approximate double tensile strain state;

c) supplemented by other tests. in-plane in the uniaxial tension, plane strain and equal bidirectional bulging strain paths for accurate determination of the forming limit diagram the ultimate strain can be supplemented by other test methods such as uniaxial stretching, hydraulic bulging and cylindrical convex bulging.

When the lubrication condition is not good, it is easy to produce a phenomenon in which the double necking and the rupture position are far from the dome. To ensure the accuracy and avoidance of test results Multi-peak phenomenon of strain distribution when using the fitting method to calculate the ultimate strain is usually obtained by testing a series of samples with different widths.

Forming limit curve.

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5.1 Sample shape and size

This standard recommends the use of rectangular specimens with a length of 180 mm and a width of 20 mm to 180 mm. To obtain a complete forming limit curve, test the width of the sample to be used shall be 20mm, 100mm and 180mm, and no less than one sample with a width between 20mm and 100mm.

There are no less than two samples between 100mm and 180mm. In order to prevent the side of the rectangular sample from cracking at the mold drawing rib or the die mouth, for specimens with a constant width of not more than 100 mm, a dumbbell-shaped specimen