THE MEASUREMENT OF LONGITUDINAL DEFORMATION OF MINIATURE TEST SPECIMENS

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Abstract

The paper deals with the development of new clamping jaws which are designed for static tensile tests of miniature test specimens. The jaws are used to hold specimen of dimensions 2 x 1 - 20 mm. During the static tensile tests, there were problems with the measurement of longitudinal deformation by laser extensometer what caused unreliable stress vs. elongation curve. For the deformation measurement, an extensometer Zwick/Roell laserXtens was used. In the paper, three development levels of mechanical grips that were designed at Mechanical testing laboratory of the Regional Technological Institute (Faculty of Mechanical Engineering, University of West Bohemia) are described.

Keywords: Longitudinal deformation, miniature test specimen, clamping jaws, laser Xtens

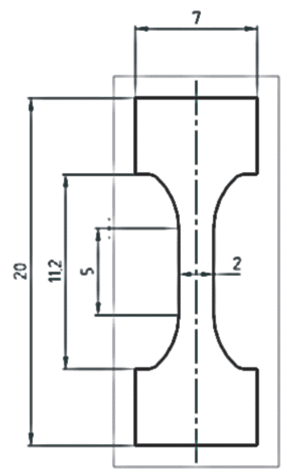
1. IMPORTANCE AND SPECIFICS OF MEASUREMENT OF MINIATURE TEST SPECIMENS

A solid material put under uniaxial tension or compression changes in length, and the change in length

$\Delta L = L - L_0$, compared to the original length L_0 is referred to as the engineering linear strain or simply linear strain and denoted by Greek letter epsilon with subscript L_0, ε_1, and defined as follows: $\varepsilon_1 = (\Delta L / L_0)$ [1].

As elevated-temperature tensile properties are sensitive to strain rate, these tests are conducted at carefully controlled strain rates [2]. The clamping jaws also must fit requirements of elevated-temperature tensile test of miniature test specimens.

Lots of cases exist when the use of standard test specimen is not possible. Benefits of the use of miniature test specimens are the low amount of testing material for manufacturing of test specimen. Another benefit is that it is possible to prepare samples from a construction in more directions than standard specimen e.g. from tubes. These specimen were used for Electrolytic nickel-plating for surface protection against high-temperature oxidation and decarburization [3] and also they are using in current projects. But the use of miniature test specimen requires large demands on clamping during the test. In this time, studies and different ways exist which deal with this problem. The paper describes the development of new clamping jaws which are designed for static tensile tests of miniature test specimens.



Dimensions in mm

Figure 1 The test specimen

2. THE TESTING OF EACH LEVEL OF CLAMPING JAWS

The clamping jaws were designed for dimensions of test specimen which are seen in **Figure 1**. The tested specimens are typically heat-treated by special procedure. That causes a high tensile strength, hardness and relatively high demands on the clamping jaws quality.

2.1. The first level of clamping jaws

The first level of clamping jaws can be seen in **Figure 2**. Each clamping jaw consists of four parts. The first part is connected with a crosshead or frame of testing machine. The second part is guided by slot and drawn by two bolts to the fixed part. The test specimen is clamped by a pair of jaw inserts. Working surface of the insert has special shaped texture which guarantees sufficient adhesion but does not cause too high stress concentration in the test specimen.

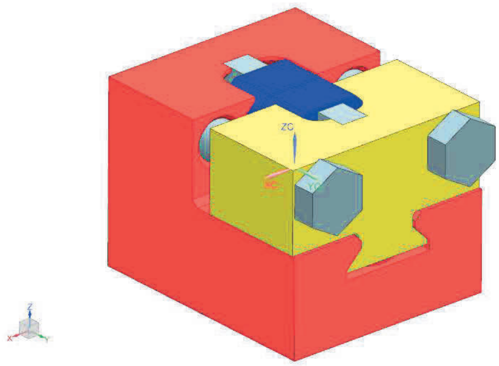


Figure 2 The first level of clamping jaws

In **Figure 3**, the position of measuring camera and the laser can be seen. The beam of the laser strikes the specimen at an angle and the body of clamping jaws impedes sufficient and correct illumination of the test specimen. The longitudinal deformation cannot be thus measured correctly.

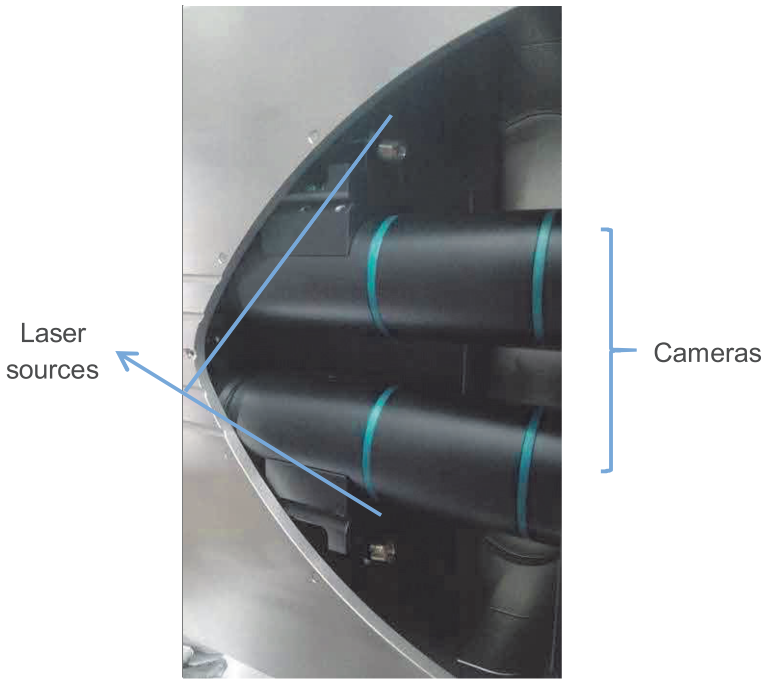


Figure 3 The measurement system

2.2. The second level of clamping jaws

These clamping jaws consist of cylindrical part with a gap similar to grip sections of test specimen, a chain and a threaded part. It uses the shape transmission. The chain guarantees the coaxiality of test specimen axis and the axis of testing machine.

For the measurement of longitudinal deformation, the laser extensometer LaserXtens was used. In the **Figure 4**, it can be seen an unreliable stress vs. elongation curve. Very likely, it was caused by a movement of specimen against the extensometer which could not evaluate the real longitudinal deformation.

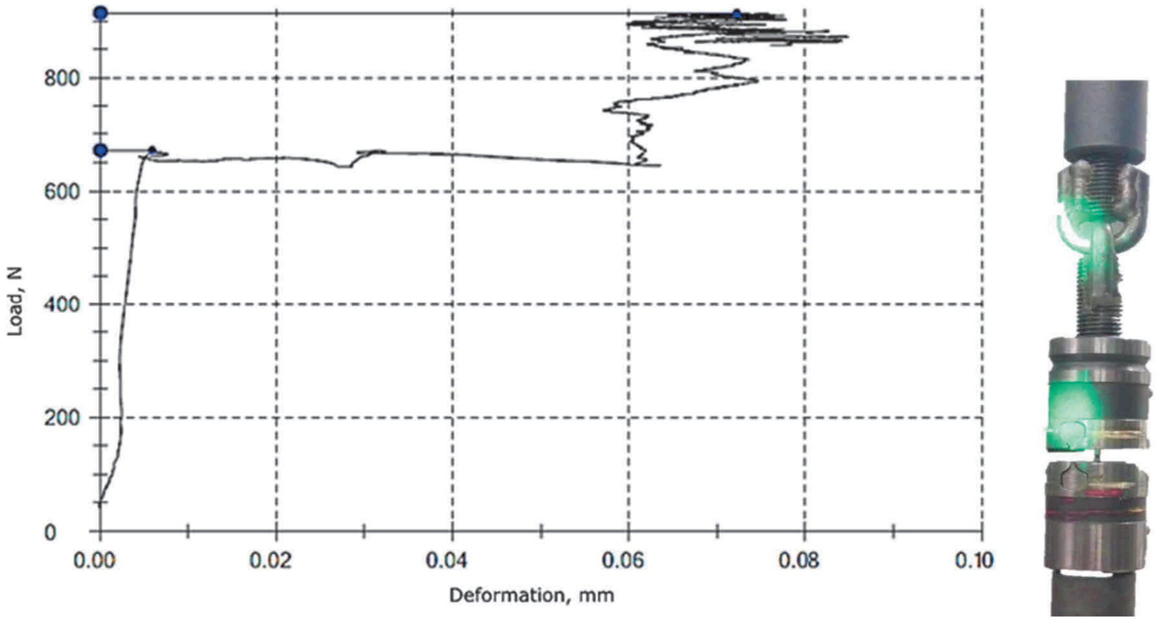


Figure 4 The second level of clamping jaws

2.3. The third level of clamping jaws

This design uses the shape transmission like the previous level. In this instance, the position of the test specimen inside the clamping jaws is specified by a pair of stoppers. Slide guiding prevents the clamping jaws from a movement from/to the laser extensometer. The assembly is shown in **Figure 5.**

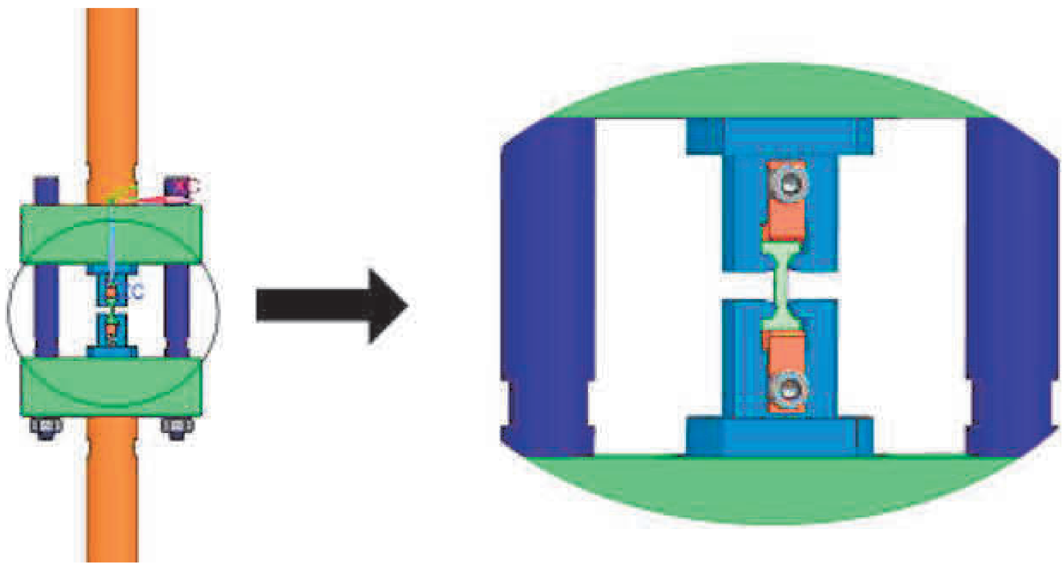


Figure 5 The third level of clamping jaws

The first experiments betoken high potential of these clamping jaws. Firstly, the clamping jaws were used with the slide guiding. Although the slide guiding was made precisely, there is friction inside the slide guiding. The record of this measurement is show in **Figure 6**. After that, the clamping jaws were used without the slide guiding and the test record was also correct. Corresponding graph and the jaw configuration can be seen in the **Figure 7**.

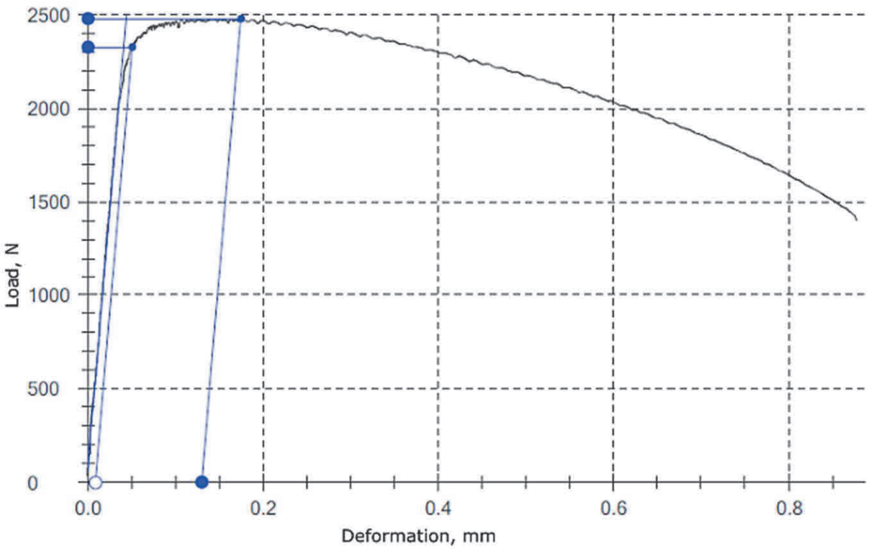


Figure 6 The record of the test

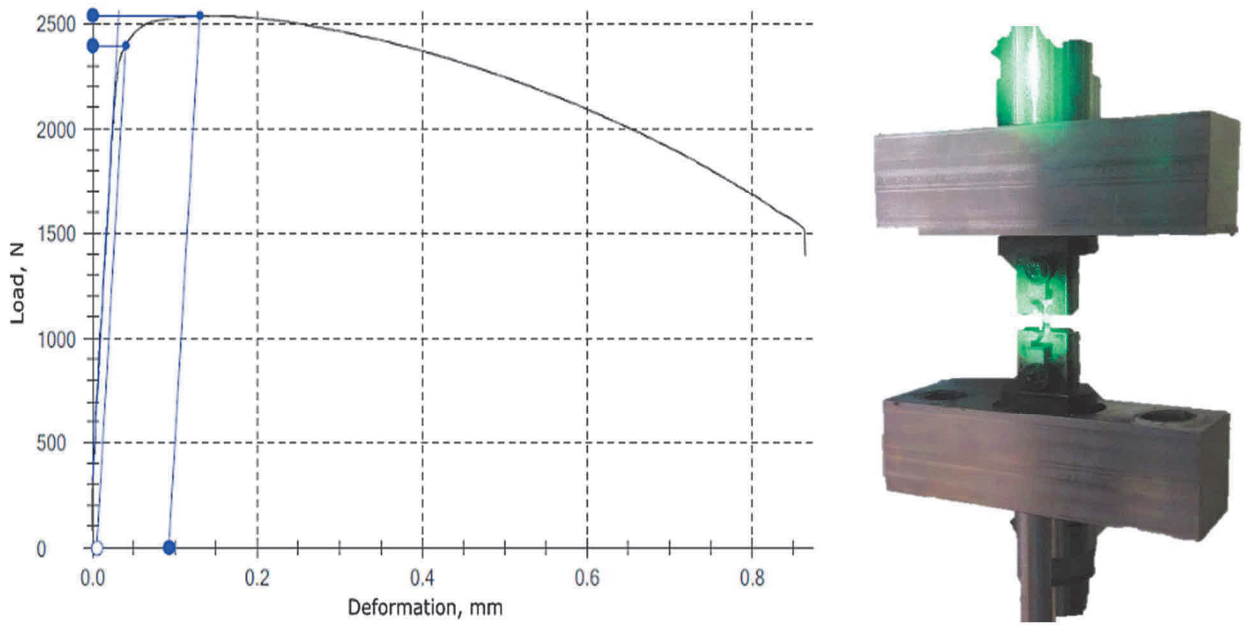


Figure 7 The record and the jaw configuration of the third level of clamping jaws

3. CONCLUSION

In the paper, gradual development of the clamping jaws was describes. Three levels of the clamping jaws were tested so far. The first tests of the third level of the clamping jaws evinced very good properties of clamping of the miniature tests specimen and the compatibility with the laser extensometer. We plan to correlate results from the miniature test specimens with traditional test specimens on the materials used in power plants, but the clamping jaws will be further tested with and without the slide guiding in future for more detailed statistics of the results. Based on the comparison, the slide guiding will be optimized alternatively and the clamping jaws will be used without the slide guiding.

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