6th International Conference
ðComputational Mechanics and Virtual Engineering ð
COMEC 2015
15-16 October 2015, Braşov, Romania

A POSSIBLE SOLUTION TO MINIMIZE ALIGNMENT ERROR ON TRACTION TESTING MACHINE

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Abstract : *Mechanical testing is usually affected by errors, the main factor is the improper alignment of the specimen, due to the catch system on the machine or to the construction of the machine itself. Today we have methods to verify the testing machine. In practice the problem is to use an existing device and to find a way to minimize all errors when testing materials. A possible solution could be to use a supplementary arrangement in order to obtain a good alignment of the specimen. The aim is to avoid any other solicitation than traction or compression.*
Keywords : *mechanical testing, alignment error*

1. INTRODUCTION

The traction testing is always accompanied by flexion, and sometimes by shear and torsion. The main problem is to minimize parasite solicitations in order to obtain good testing data. Two factors seem to be important: one is the conception of the machine and its manufacture, and second is the catch devices. Let's consider the specimen is made without errors and the operator work properly, with respect to the standard procedure.
Every testing machine has a history. Variable loadings, different operations, many testing, maybe many operators. A lot of factors which could influence its functionality. In many real situations we have to use a device with its internal problems. One of them is the alignment. The misalignment between the load axis and the axis of the specimen contributes to significant variation of the material properties.
Regarding the procedure, in general the standards do not make reference on the alignment specifications. The ASTM E1012 [1] contains a procedure to evaluate the bending in tension testing. In Europe exists a code of practice published under the name EUR 16138 EN [2], where is described the procedure and the equipment to use in order to determine the bending introduced in tension test of smooth specimens. Recently, the ISO standard 23788:2012 (en) [3] proposes a procedure to verify the fatigue testing machines, and a method for verifying the machine alignment by means of measuring the bending on the surface of a strain-gauged specimen was proposed in [4].
An optimal solution of the problem could be a self-alignment of the specimen. Is it possible? Some arguments are presented further.

2. TECHNICAL CONSIDERATIONS AND SOLUTION

In the standard [3] the alignment is defined as "coincidence of the loading axes of the load train components, including the test specimen".
Some sources of misalignment are [2]: poor alignment in the load train, inadequate test machine alignment, insufficient test machine lateral stiffness, poor conformance of the specimen center line with top and bottom grip centers and inaccurate machining of the specimen. The problem becomes more complex as the misalignment varies also with the magnitude of the applied loading.
The rigid body motion could be considered like a superposition of a translation and a rotation. The rotation seems to be important in the alignment problem. A way to solve this is to decouple the rotation on two perpendicular axis. A good example is the universal joint. If we use two universal joints, one before the specimen and other after, the misalignment in the load train of the testing machine is reduced. It appears a self-alignment of the specimen. Note the universal joint introduces at least three pieces and two coupling with pins. A

kinematic schema is done in figure 1. The joint is able to allow rotations around two perpendicular axis under the superior grip and also rotations around two perpendicular axis above the inferior grip.

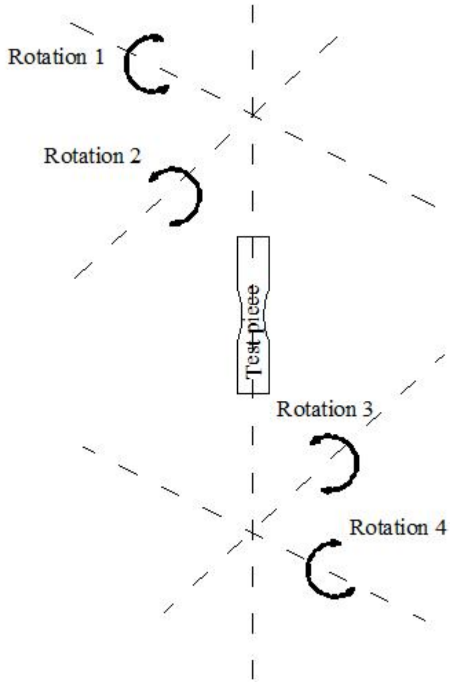

Figure 1: Kinematic schema

Therefore some problems should be examined carefully. One is the presence of friction in couplings, and this generates a residual bending for the specimen. Other is the stiffness of the joint in relation with to the stiffness of the specimen.

There are some basic requirements for a testing machine [2], [4]:

1. The load train should be as short and as stiff as possible,
2. The number of components of gripping devices and the number of pieces of the load train should be reduced, in order to reduce the number of mechanical interfaces to a minimum.

The global stiffness of the load train depends finally on the number of pieces (joint pieces) and their volume. In fact is necessary to consider the specimen volume relative to the volume of the load train components between the grips. The design of this auxiliary self alignment system should be based on the analysis of the global and local stiffness, considering the specimen and all the components of the load train.

3. CONCLUSION

The machine alignment of uniaxial test systems could be improved using auxiliary pieces like universal joint. A practical problem to solve is the friction in cylindrical couplings. A design problem is to calculate (optimize) the auxiliary pieces, concerning shape and dimensions, to ensure the maximum stiffness possible.

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