Test&Motion

Application Module:

3 /4 Point bending test for construction materials (LOP)

Version 1.0 (State 20160819)

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1 Introduction

Dear customer, thank you for choosing a product of **DOLI Elektronik GmbH**. **Test&Motion** is a modern application for the operating systems Microsoft Windows XP/7/8/10©.

This manual does not deal with the **Test&Motion software** in general but with the application module Plastics Tensile Test BA 1 in particular. Hence, it is recommended to read the **Test&Motion** application manual in order to get familiar with the software. Please follow the demands and safety hints listed in the manual!

1.1 Symbols

The different symbols in this manual will allow you to find your way more easily.

Table 1: Symbols and their meanings.

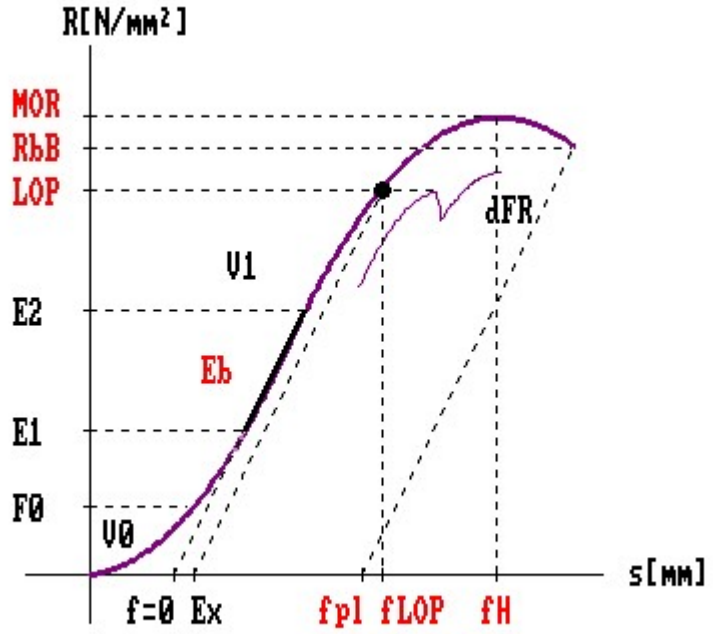
Symbol	Meaning
	**Safety Instructions:** **In order to avoid interruptions in the work flow as well as damages to man and machine, follow the safety instructions at all cost.**
	**Job/work instructions:** **Instructive part of the document with precise work instructions.** **Here you are asked to do something.**
	**Information:** **General information and descriptions of working procedures, etc.**
	**Note:** **Important note for the operation, the function or for the working procedures.**
	**Tip:** **Gives tips for easy handling of the Test&Motion Software, the EDCs or the testing instrument.**

2 Application module BA 1: 3 /4 Point bending test for construction materials (LOP)

2.1 Field of application

Determination of bending tensile strength (MOR), bending yield limit (LOP), bending limit and remaining deflexion of construction materials in 3 or 4 point-bending tests.

2.2 Test graphic BA 1



2.3 Input values BA 1

1. Click Menu Test → Command Settings → Input values. Here you can find expedient input values for this test regulation, already. If necessary adjust the values to your needs.

Table 2: Input values for test BA 1.

Parameter	Meaning	Dimension / Selection possibilities
E1	Rise limit 1	[N, kN] or [N/mm²]
E2	Rise limit 2	[N, kN] or [N/mm²]
Ex	Plastic deformation for the determination of the LOP value	[mm] or [%]
dFR	Recognition threshold for decrease in force for LOP-value	[N] or [%]
b	Sample width	[mm]
h	Sample height (depth)	[mm]
l	Sample length	[mm]
m	Sample weight	[g]
I	Moment of inertia	[mm^4]
S.m.	Section modulus	[mm³]
Choice:	Kind of test	• 3-point bend test • 4-point bend test
Choice:	Search for rise limits	• Automatically • Input values E1 and E2

2.4 Results BA 1

1. Click Menu Test → Command Settings → Results. Here you can already find expedient results. If necessary, adjust the values to your needs.

Table 3: Results for test BA 1.

Parameter	Meaning	Dimension
FH	Maximum test force	[N]
MOR	Bending tensile strength (bending stress at maximum force)	[N/mm²]
fH	Deflection at maximum test force	[mm]
AH	Strain of the outer fibre at max. test force	[%]
LOP	Bending yield limit (bending stress at Ex)	[N/mm²]
fLOP	Deflection at LOP-value	[mm]
ALOP	Strain of the outer fibre at LOP-value	[%]
fpl	Plastic deflexion at sample break	[mm]
FB	Breaking force	[N]
RbB	Bending strength (bending stress at sample break)	[N/mm²]
Eb	Flexural module	[N/mm²]
rho	Density of the test body	[g/cm³]
S0	Sample cross-section	[mm²]
PA1	Sample dimension 1 (not for all sample shapes)	[mm]
PA2	Sample dimension 2 (not for all sample shapes)	[mm]

2.5 Hints for the test BA 1

2.5.1 Pre-load F0

- For test control deflection is set to 0 after reaching preload F0.
- F0 must be entered in such a way that the test arrangement is connected in a non-positive way (contact force bending peen to specimen).
- Switch test rate from V0 to V1.

2.5.2 LOP-value (bending yield limit)

- The LOP-value will determinate above the input value Ex (plastical deflection in [mm] or plastical strain of the outer fibre [%]) respective dFR (force dropping [N] or [%] between F0 und FH) . First in force area from F0 up to FH will searched to one local force maximum, whereas the following force dropping is greater or equal the entered minimal value dFR. As such maximum was found, then is the determinated LOP-value equivalent the flexural stress at this point. In other case is the LOP-value equivalent the flexural stress at the point of intersection of the curve with this at the input value Ex after rightwards staggered straight line in the force (flexural stess-) / defection-diagram.
- Reference basis for the determination of the plastical deflection is the increase of curve (look at determination of the increase), in this in point of intersection of the increase straight line with the x-axis the deflection will staid to 0. (Calculation after the test).
- The LOP-value will determinate over the first satisfied criterion . Must the LOP-value will determinate well directed over only one criterion, is through corresponding input the 2.criterion set ineffectually, p.e..

  LOP over Ex determinate: dFR choose very great

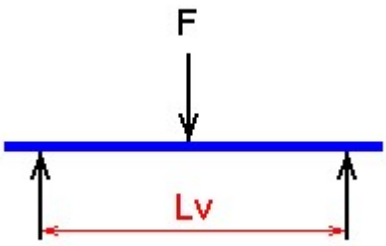
  LOP over dFR determinate: Ex > fpl key in

2.5.3 Determination of the increase

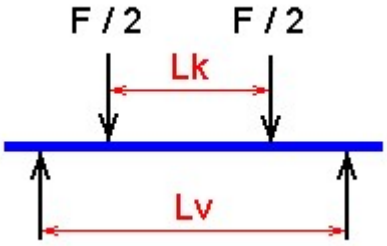
- Automatic determination of the increase: It will determinate the maximal increase between F0 and FH about the area in value by 20 % of FH. (selection is only meaningful in the case of constant curve increase)
- Determination of increase between the given limits (input values) E1 and E2. The limits are entered in [N, kN] or [N/mm²], and should be greater than preload F0.

2.5.4 Types of loading

3 point load:



4 point load:



2.5.5 Calculation of bending stress

3 point load:

$$Rb = \frac{3\ Lv}{2\ b\ h^2} * F$$

4 point load:

$$Rb = \frac{3\ (Lv - L\ )}{2\ b\ h^2} * F$$

F Force [N]

Lv Support width (distance of the bending supports)

Lk Distance of the force introduction

b Sample width

h Sample depth

or

$$Rb = \frac{Lv\ h}{12\ I} * F$$

$$Rb = \frac{(Lv - Lk)h}{12\ I} * F$$

I Moment of inertia

or

$$Rb = \frac{Lv}{6\ S.m.} * F$$

$$Rb = \frac{Lv - Lk}{6\ S.m.} * F$$

S.m. Section modulus

2.5.6 Calculation of deflection

In 4 point bending test, the deflexion is multiplied by factor 1.15.

2.5.7 Calculation of the strain of the outer fibre

3 point load:

$$Ab = \frac{600\,h}{Lv^2} * f$$

4 point load:

$$Ab = \frac{400\,h}{Lk^2} * f$$

Ab	strain of the outer fibre[%]
F	deflection [mm]
Lv	span (distance of bending support)[mm]
Lk	distance of force application in [mm]
b	width of sample [mm]
h	hight of sample [mm]

2.5.8 Calculation of flexural modul

3 point load:

$$Eb = \frac{Lv^3}{4\,b\,h^3} * \frac{F2-F1}{f2-f1}$$

4 point load:

$$Eb = \frac{3\,(Lv-Lk)Lk^2}{8bh^3} * \frac{F2-F1}{f2-f1}$$

Eb	flexural module [N/mm²]
F	force [N]
F	deflection [mm]
Lv	span (distance of spending support) [mm]
Lk	distance of force application [mm]
B	width of sample [mm]
H	hight of sample [mm]

2.5.9 Correction possibilities

After a test the input for the LOP value (Ex and dFR) and for determination of the increase can be corrected. Subsequently the test results will be calculated again.

2.5.10 Sample dimension

- **b** Sample dimension (width) and ‘h’ (height, depth)
- **I** Moment of inertia and ‘h’ (height, depth)
- **S.m.** Section modulus

2.5.11 Pairs of reference values

Three pairs of reference values are available. Here, you can define the wanted result type by chosing the dimensions for these pairs See the following table:

Table 4: Meaning of the input and output values.

Dimension of input- and output values	Meaning
N, kN	Load
N/mm²	Stress
%	Strain
mm_dL	Elongation
mm_S	Crosshead travel
s, min, h	Time period
Dim User1	User defined meaning 1
Dim User2	User defined meaning 2
…	…
Dim User30	User defined meaning 30

2.5.12 Behaviour at Av

The elongation/strain can be detected either via the crosshead travel or by using an extensometer. As a option, a width extensometer can be used to detect the change in sample width during the test, in order to detect the Poisson's ratio of the sample. The software offers the possibillty to remove the extensometer for length as well as the one for width during the test. This happens at strain value Av.

When strain value Av is reached, the test can be continued in one of the following manners:

1. **Continue test:** The test will be continued in a normal manner. Av has no influence.
2. **Stop test:** The test will be stopped at reaching Av.
3. **Pause test, drop extensometer:** The test will be interrupted. Now, the user can remove the clip gauge before continuing the test. An automatic extensometer will be removed automatically before the test continues.
4. **Continue, drop extensometer:** The test will not be interrupted. A message will inform the user about the possibility to remove the clip gauge. However, the test will continue during removing. An aotomativ extensometer will be removed automatically during the test.

Note: **Please note that the tensile characteristics of plastics do very much depend on the test speed. Hence, we recommend to prefereably not interrupt a test if possible!**