The test report

For understanding the technical terms we would like to refer to the glossary on the test report.

The results breaking limit, ultimate strength, elastic limit and recommendations are shown on the test report as well as tension in N/mm2 and in the measured N as in percent (%) referring to the breaking limit. This triple information allows an immediate understanding without converting.

The tension values (N/mm2) are interesting because you can compare different diameters with each other. With the information of loads (N) you can arrange the limits on the diagramm. If you read the values at the scale on the left side of the diagram and if you search the crosspoint which is on the same hight on the curve, you get an optical impression of the position of the whole curve. For judging about the often used safty deduction one can use the percent values referring to the breaking limit. This tripple value listing allows an immediately understanding without conversion.

But how do we find the values which are printed out on the test-report? At first we measure and store the changes of the length and load deflection during the tensile test. This amounts the printed out diagram curve.

There are different types of stretchings on the measured extension of the wire up to the breaking point. You can differ between reversible and irrerversible extension or like the standardisation says between elastic (àLe) and non-proportional extension (àLp).

If you only load the wire a little and then reduce the load, the wire gets back its original length. So the material has only been stressed within the elastic elongation. You can compare this with an aircraft wing or with a car which has the same shape after using it without accident like in the beginning.

If the load rises over the elasticity limit, there is a permanent deformation (r) after the reduction of the load. According to our comparison with the car this would be a dent. If you drive a car which has a small dent there are elastic and plastic deformations (àLt) at the same time. But there is no more normal use possible if the dent is really big.

The standardisation defines the elasticity limit where the non-proportional lengthening reaches 0,01% of the test length. In our test arrangement with a test length of 50 mm in the extensiometer this corresponds to a plastic deformation of 0,005 mm.

For the determination of the different stretch limits on the load deflection curve first we have to place a parallel to the beginning of the diagram. We define the beginning of these parallel at 20% and the end at 40% of the maximum load. We could put the limits also lower and more narrow. At lower placed values the smallest inaccuracies can lead to extrem variations.

We intentional choosed an interval, so that we can test all materials which are used in the harpsichord manufacturing with the same adjustment. Because of this we have got the possibility to reach an optimized comparison of the test results.

The so defined parallel shows a certain gradient in the load and length deflection curve which is used for calculating the stiffness or the spring stiffness constant. If you transfer the parallel on until the sample is elongated by 1mm, you receive the spring stiffenss constant in N/mm. As the load is very dependent to the diametre of the sample, you can compare different materials only with the same diametre. The spring stiffness constant flows into the calculating of the inharmonicity.

The modulus of elasticity is a material index which describes the tension of an elongation of the measuring length by 100% (spring stiffness constant x measuring length / sample cross section). The elacity modulus is needed in the calculation of the scaling. As it concerns of a load per cross section (tension) it is possible to compare the different diametres with each other. At the same time you find out that the elasticity modulus is dependent on the alloy and also on the cold forming while drawing the wire of the material.

For defining the 0,01%-elastic limit the parallel line is moved by 0,005mm to the right. The point of intersection is the elastic limit.

Exactly that way you define the 0,2%-ultimate strength (Rp0,2), but the parallel has to be moved by 0,1mm to the right in the diagramm. As the percent values of the non proportional elongation (p) refers to a measuring length of 50mm, these are the measured elongations of 0,005 and 0,1mm on our diagram.

Cold formed string wires do not have a yield point with afterwards yielding area. That‘s why this cannot be defined. On materials without yield point we calculate the 0,2%-ultimate strength alternatively. We think that this is too rough for the practical use in the harpsichord manufacturing. On the other hand we think that the elastic limit is too exact. So we have determined an additional limit (Rr0,03) which we defined at 0,03% plastic deformation. We call this the recommended maximum load on the diagramm.

Of course this can be only a reference value which can be passed or fallen short in practice. For to make comparing different tests of different materials more easy, we have choosen the same limit for these recommendations for all materials.

For the practical view on the test report, we have converted the four different limits also into scaling lenghts for c2 at a pitch of a1 = 415 Hz and 440 Hz.