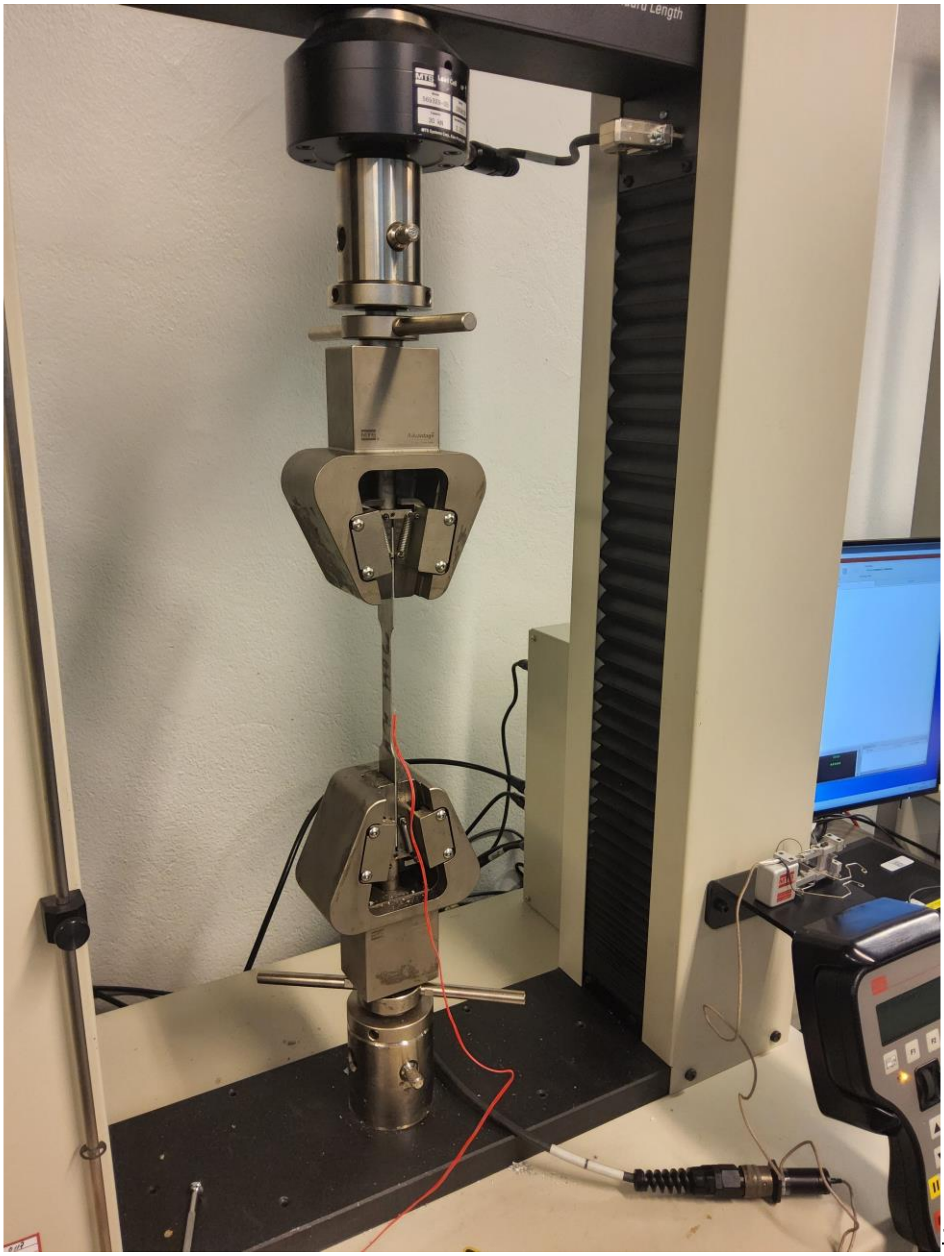
Standardized tensile testing

On steel 304


[1]

Summary

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[1] Test running

4. Reference

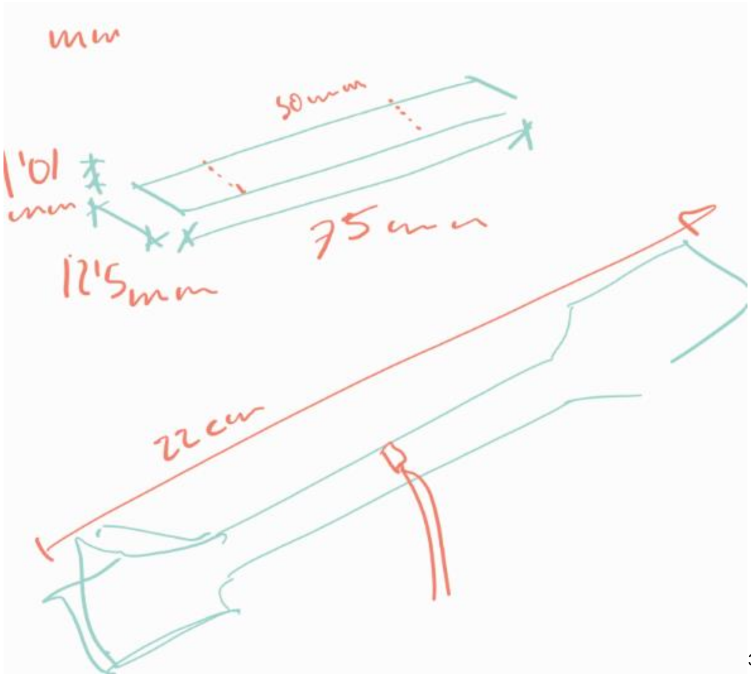
1)-Introduction:

Tensile testing is a basic mechanical measurement to detect how a material resists loaded tensile forces until it fractures. Standardized tensile test is used but with the help of strain gauge and extensometer we measure strain in the transverse and axial strength in the longitude direction. Steel 304 is used as a specimen for testing. It has a minimum of 18% chromium and 8% nickel, combined with a maximum of 0.08% carbon. We will analyze the strain generated in the material and its fatigue.

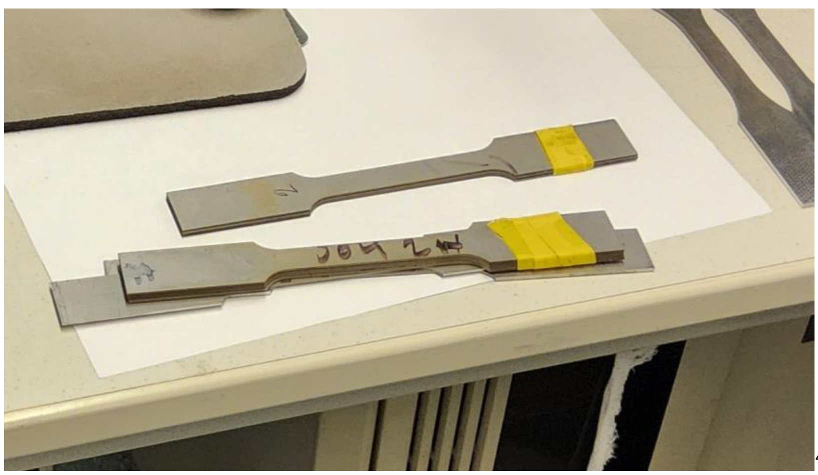
2)-Experiments:

Steel 304[2] is used as a specimen for testing. Standardized tensile strength (SFS-EN ISO 6892-1:2019) is performed. Extensometer and strain gauge is used for measuring the axial displacement, strength and strain gauge is used for measuring strain in the material. Force is applied on the specimen until it breaks. The machine goes up to 30KN maximum and 10V is approximately 30KN force. After applying the force, the specimen starts elongating and breaks until its reaches maximum stress.

[2] Stainless steel 304 and stainless steel 304L are also known as 1.4301 and 1.4307 respectively. Type 304 is the most versatile and widely used stainless steel. It is still sometimes referred to by its old name 18/8 which is derived from the nominal composition of type 304 being 18% chromium and 8% nickel. Type 304 stainless steel is an austenitic grade that can be severely deep drawn. This property has resulted in 304 being the dominant grade used in applications like sinks and saucepans. Type 304L is the low carbon version of 304. It is used in heavy gauge components for improved weldability. Some products such as plates and pipes may be available as "dual certified" material that meets the criteria for both 304 and 304L. 304H, a high carbon content variant, is also available for use at high temperatures. Properties given in this data sheet are typical for flat-rolled products covered by ASTM A240/A240M. It is reasonable to expect specifications in these standards to be similar but not necessarily identical to those given in this data sheet. https://www.thyssenkrupp-materials.co.uk/stainless-steel-304-14301.html



[3]


[4]

There is little procedure to attach the strain gauge to the material with glue. First wipe it with clean tissue and then put glue to stick it on the material in the center of the specimen. There are two separate computers showing the strain and strength on individual screens.

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[3] specimen demotions

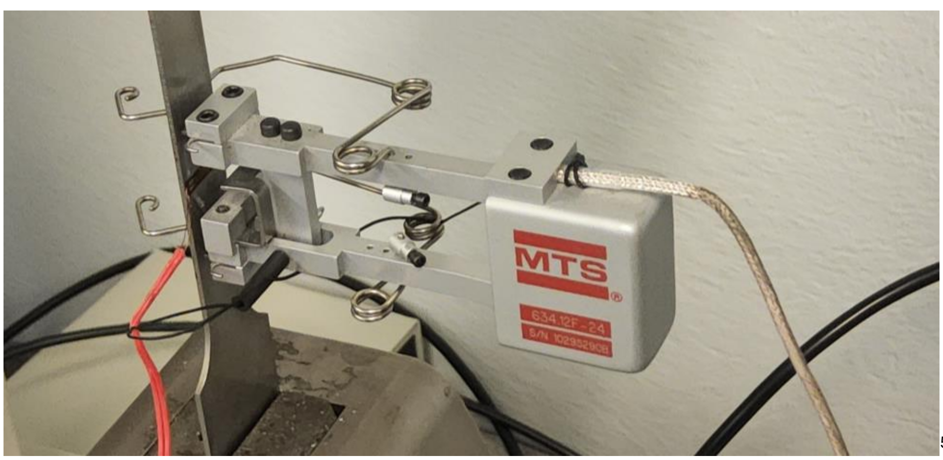
[4] Specimen: steel 304

Extensometer technique

The ASTM standards recommended the use of an extensometer for accurate measurement of strain. For the highest possible accuracy, a class 0.2 averaging high-resolution extensometer, calibrated according to EN ISO 9513 over the restricted strain range appropriate to the test, is recommended for modulus measurement. Strain measurement is required in the determination of characteristic values of a material. The tensile modulus, Young's modulus, yield point, strain at break, r-value and Poisson’s ratio are typical values determined with an extensometer.

Advantages of Extensometer

- Extensometers provide far more accurate and repeatable measurements than measurements based on the motion of the testing machine’s crosshead, which would include errors caused by deflections in the testing machine’s load cell and drive components.
- Extensometers come in a great variety of shapes, sizes, measuring capacities, and temperature ratings, and they may contact the specimen directly or make measurements optically without contacting the specimen.
- Extensometers are reusable and last for years, and they are very cost-effective compared to adhesively bonded strain gages or digital imaging measurements.



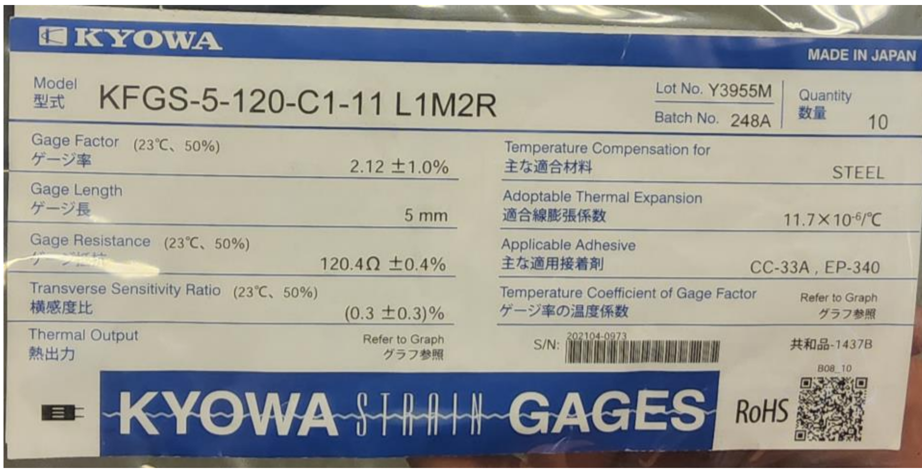
[5]

Strain Gauge technique

Strain gauge is one of the tools most often used in strain measurement owing to their apparent accuracy, low cost, and ease of use; however, they are frequently misused, and

[5] extensometer

the causes of their measurement uncertainty are badly estimated. There are two reasons for measurement uncertainty: the first is due to the measurand, and the second is due to the uncertainty introduced by the measuring system. It is also important to note that systematic errors have an effect on the global accuracy of the measuring system, while random errors affect the system's precision and consequently its accuracy.



[6]


[7]

<u>Advantages of strain gauge:</u>

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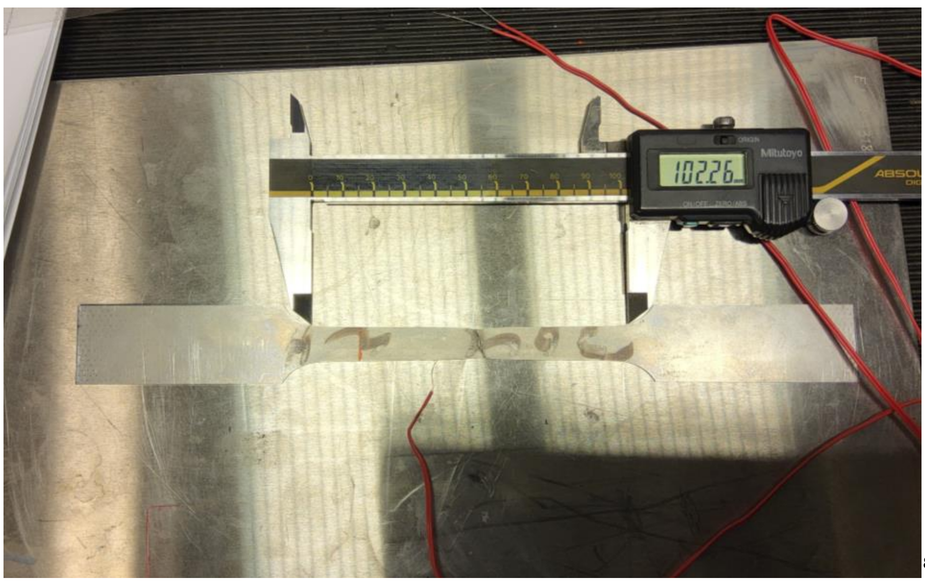
[6] Strain gauge information 120 Ω

[7] Strain gauge installed with glue CC3A

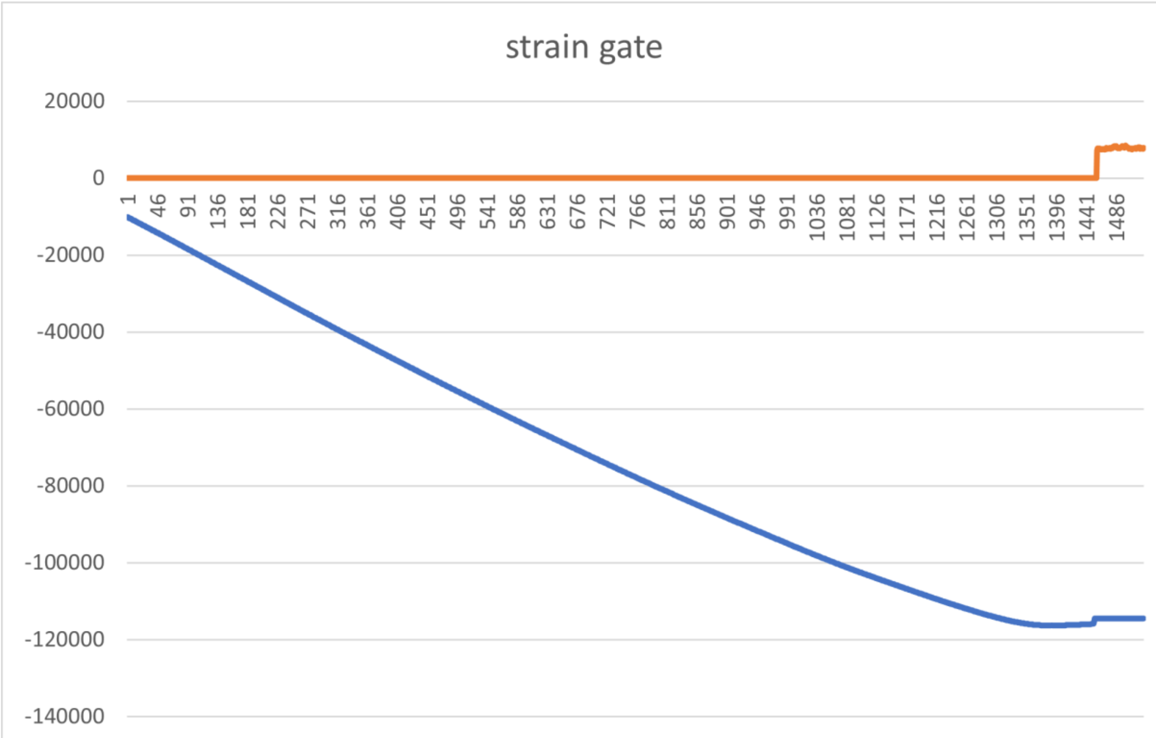
- Strain gauges are accurate, reliable, and versatile, able to measure strains from micro to macro levels in static or dynamic situations in various directions and locations on the material.
- Easy to install and use, as they can be attached to the material with adhesive bonding, spot welding, or soldering and connected to various instruments for data acquisition and analysis.
- Strain gauges are cost-effective and durable; they are inexpensive and widely available in varied sizes, shapes, and materials, and can withstand harsh environments and repeated loading cycles without significant degradation or drift.

3)- Discussion & Results:

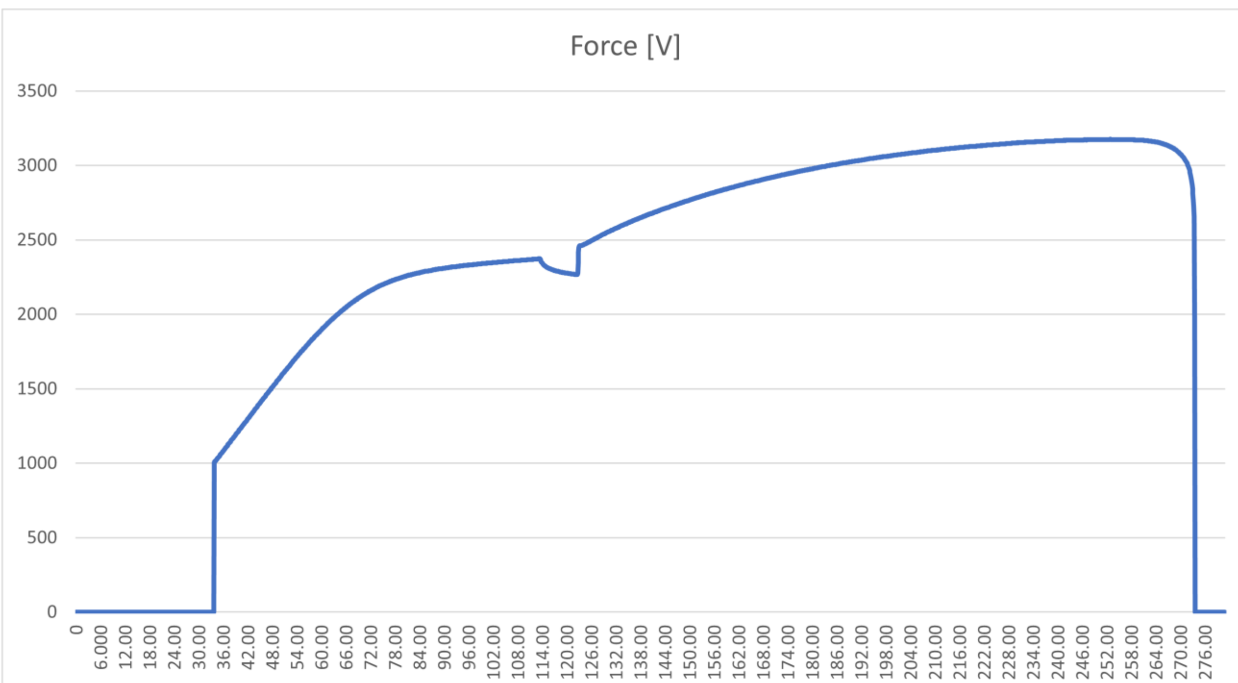


[8]

[8] Specimen after test

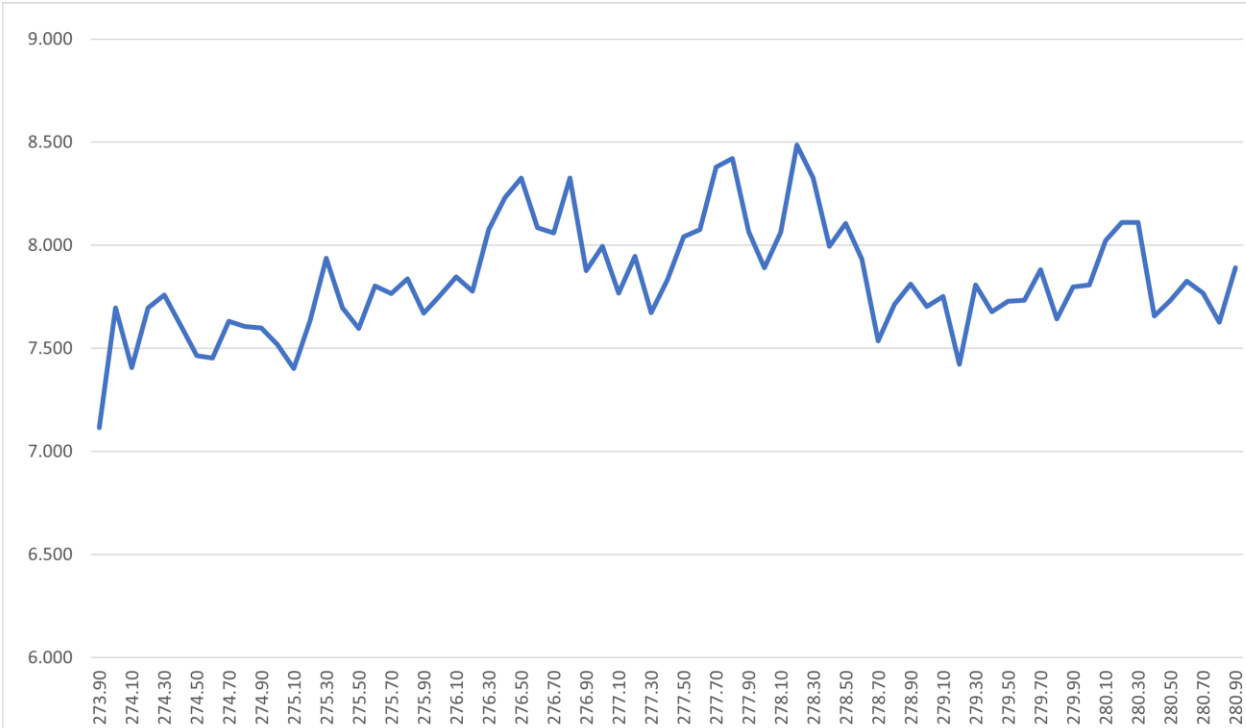


[9]



[10]

[9] Strain gauge
[10] X= time Force in V
The first inflection point is the change of 1’125mm/min to 11’25mm/min



[11]

4)- Reference:

1. Stainless Steel 304 - 1.4301 Data Sheet thyssenkrupp Materials (UK) https://www.thyssenkrupp-materials.co.uk/stainless-steel-304-14301.html
2. SFS-EN ISO 6892-1:2019 https://sales.sfs.fi/fi/index/tuotteet/SFS/CENISO/ID2/6/864938.html.stx

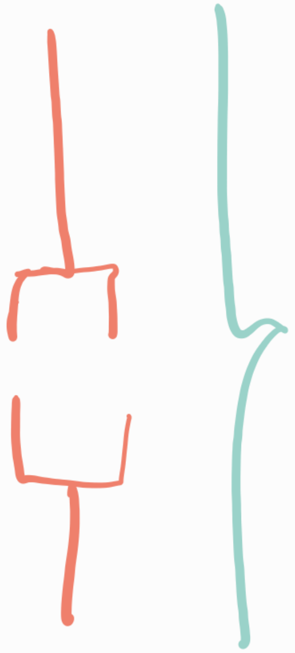
3. Strain Gages, KYOWA https://product.kyowa-ei.com/en/products/strain-gages

4. Idem. https://product.kyowa-ei.com/en/products/strain-gages/type-kfgs

[11] Force scaled

ANNEX

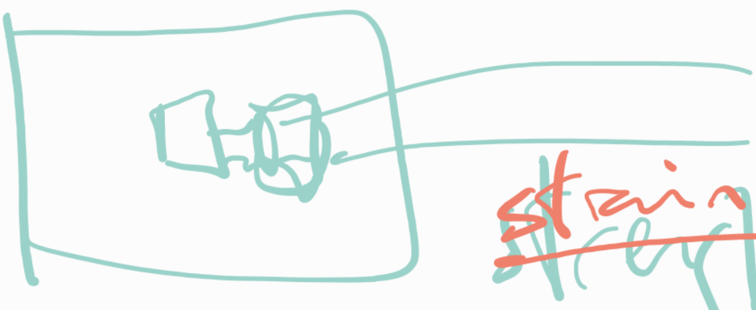
Standarized Test



Axial → 
strength
small

Extensiometer

50% of strength



strain
~~strength~~ gages
(4%?)

Glue is defforming during the performance

304 steel

- ask for composition & company

→ standard test

SFS-EN ISO 6892-1:2019

↳ width & length
Table B.1

↳ specimen 1

↳ $l = 75$ mm

Gripping length 50

How do strain gages work? (Kiowa manual)

Resistance changes when compression & tension

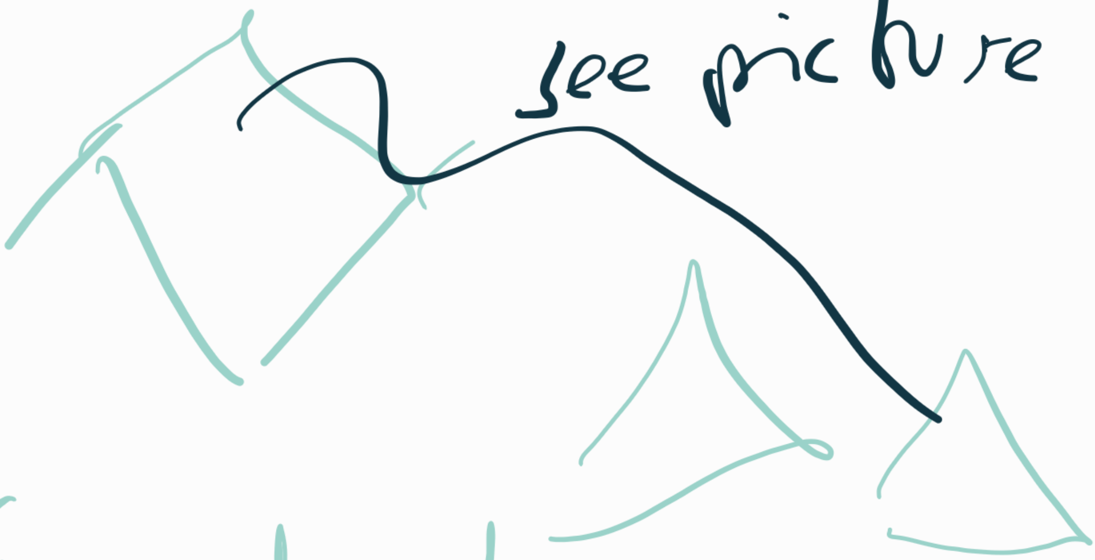
$$\frac{\Delta R}{R} = K_s \frac{\Delta L}{L} = K_s \cdot \varepsilon$$

two types of st. gates.

120 Ω 350 Ω

Measurement correction

see picture



(biaxial gates  triaxial gates )

strain gates

↳ residuals measurements of a welding (triaxial)

Poisson ratio to calculate through the extensometer

Strain gel → transfer strength
→ distance

Tension tension

Transfer Volts → kN

30kN = 10V

Extensiometer 0'5 · 1mm (50%)

KFGS-3-120-C1-11 L1M2R

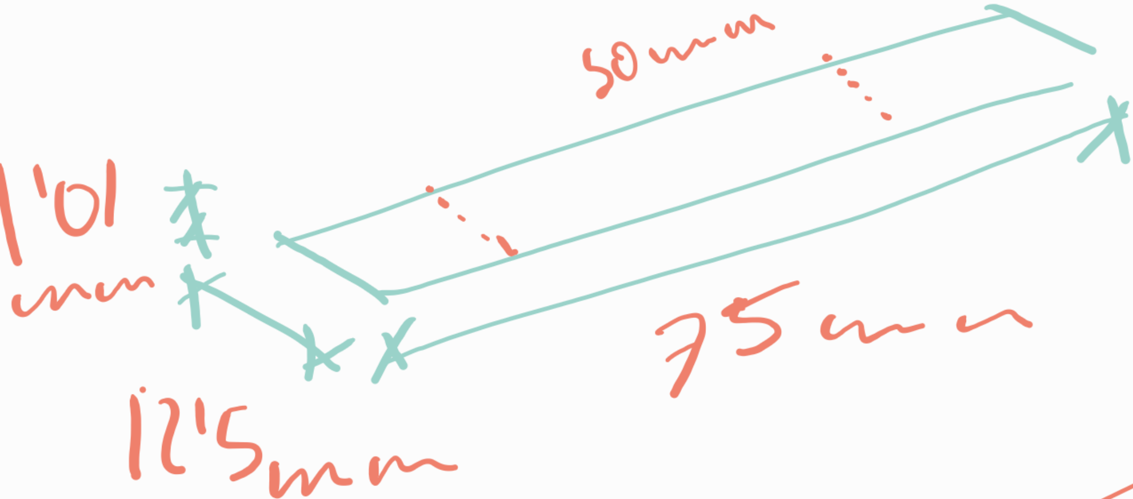
5mm

120Ω

Glue CC3A

sciunacullate (superglue!)

mm



SFS document -
-EN ISO → pg. 17 10.3
Testing
rates

10.3.2.2

(slow straining rate?)

pg. 32 → Method A

(Elongation of the material?
→ breaking point?

= standard tests & speed up the
timing

(report for comparing with other groups and for self help)

anything that went wrong or so

strain gauges tilted ...

how affected

measuring dif. strains
img. correlation

advantages & disadvantages

extensometer no longer deformations

formulas used
strain gauges used

different choices?

puason ration

↳ lateral after deformation is non puason ratio

Elastic range to get good results

↳ explanation on the standard

↳ to deviate from the standard you should be completely sure why and how

$\times 75$

0'01875 mm/s | 0'00025 s

$\times 60$

1'125 mm/min

start

$\times 5$

55'625 mm/min

10

11'25 mm/min

end

0'0067

max allowed

$\times 75$

0'5025

$\times 60$

30'5 mm/min

velocity handling of the machine can be checked afterwards

when yelding is happening to the material (plastic) the velocity goes up we want to define the yield strength

↳ 1'5%

extentiometer

25 mm

manage sure this while installing

pin

we need difference on change wrt in value

So signal

↳ mm/mm

↳ gives more visual number when measuring the strain

Calculate Mpa from data files

Elongation of 30 mm

$$\frac{30\,mm}{75\,m} = 0'4 \rightarrow 0'4\%$$

of elongation until break

(paint disolved)