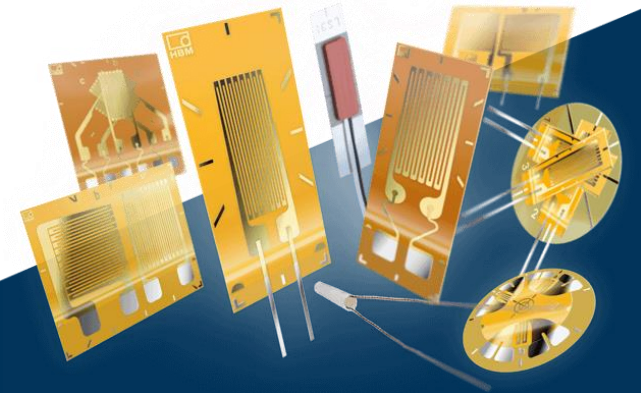


Welcome to the “Measurements with cylindrical strain gauges in bolts” Webinar

The presentation will begin at 10am Central time

All attendees' microphones are muted for the entire webinar session. Be sure your speaker is active and join the audio conference.

If you have a question, please send it to the host using the “Q&A” function. Questions will be answered at the end of the presentation.



Organizational Information

- All participants' **microphones** are **muted** during the webinar.
- Please do not forget to **activate** your PC **speakers** to enable **audio** or connect **headphones** to your PC. You may have to take the step of joining the audio conference to hear sound.
- Please type any questions you have into the WebEx Q&A dialog
- You can open the Q&A window by selecting the “Q&A” icon in the WebEx toolbar at the top of your screen:



- Today's presentation will be E-mailed to all attendees. The webinar will also be posted on our website: <http://www.hbm.com/en/3157/webinars/>
- If you have additional technical questions, feel free to contact our Americas technical support team at support@usa.hbm.com or the European technical support team at support@hbm.com.

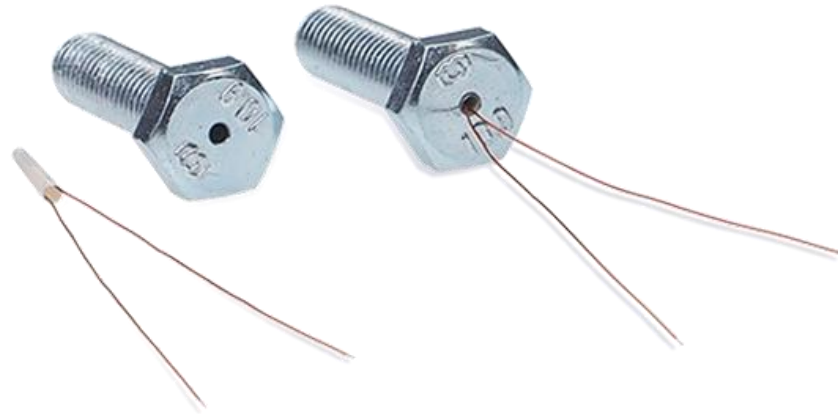
Arnt-Henning Andersson

- ▲ Head of EMEA Engineering Services at HBK
- ▲ B.Sc in electrical engineering
- ▲ 23 years of experience with strain gauges in the field
- ▲ Specialty – Getting strain gauges to live in harsh environments, ex Oil&Gas, offshore wind...



Agenda

1. What are cylindrical strain gauges?
2. Where are cylindrical strain gages used?
3. How do I install these particular strain gauges?
4. What can I achieve with these strain gages, where are the limits?

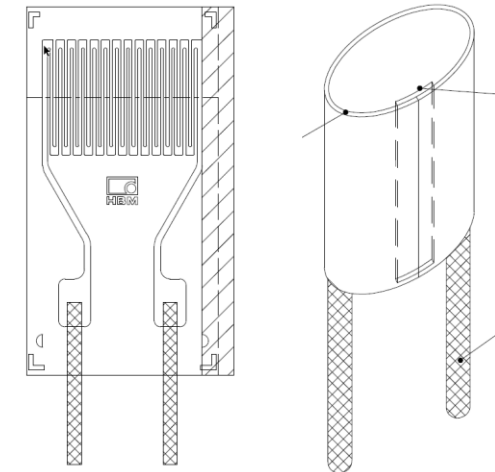
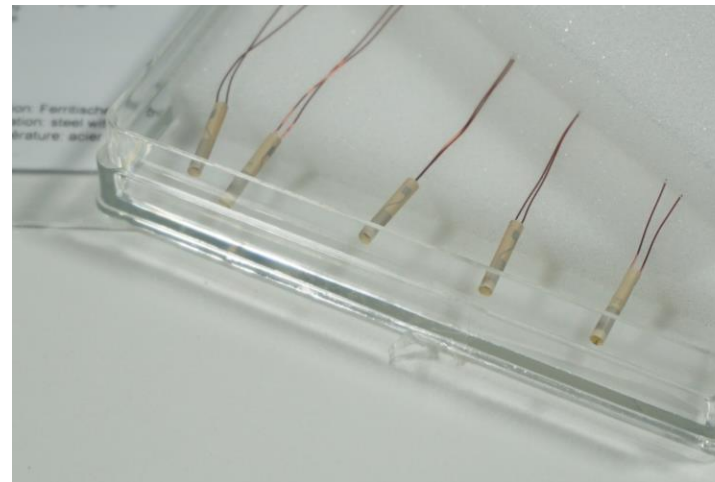
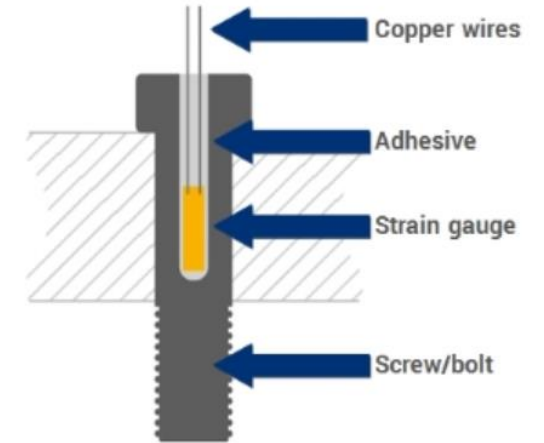
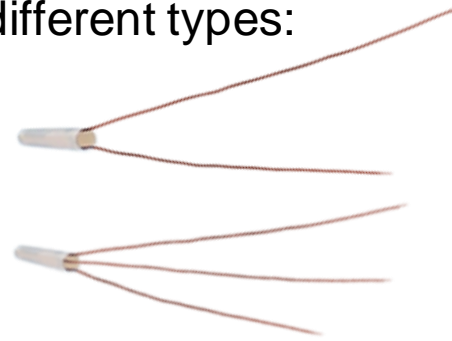


What are cylindrical strain gauges?

- Cylindrical strain gauges are planar strain gauges rolled into a cylinder.
- With HBK, there are two different types:

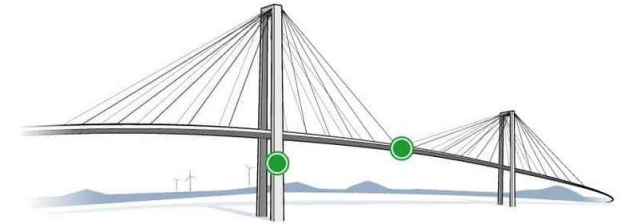
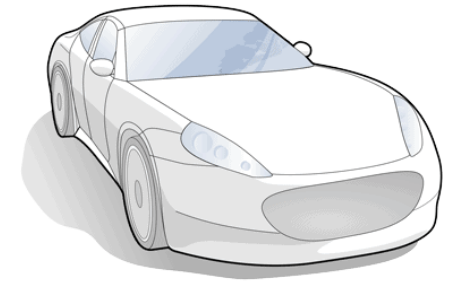
- 1-LB11-3/120ZW

- 1-TB21-3.3/1000HW

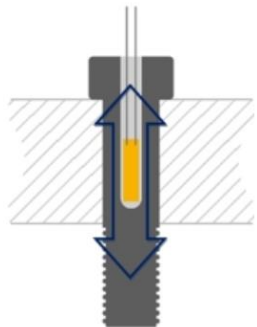


Where are cylindrical strain gages used?

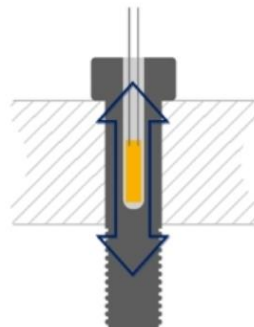
- Axial forces -> Turn your existing structure into a force sensor where installing conventional force sensors is not possible.
- Strain -> validate calculated data from an FE model in operation.
- Dynamic loads -> Collect information about the vibration behavior of your object



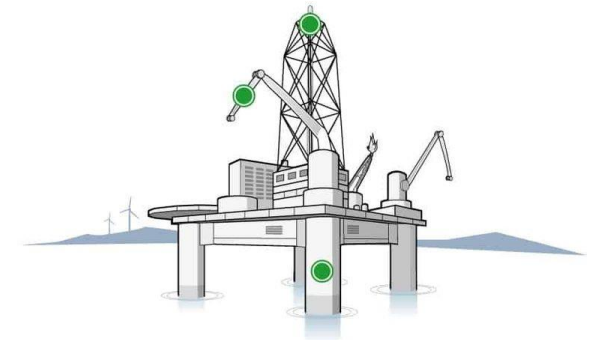
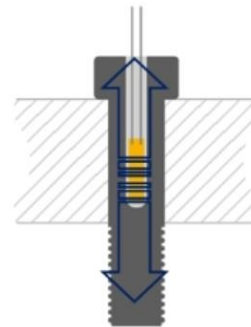
Axial Forces



Strain

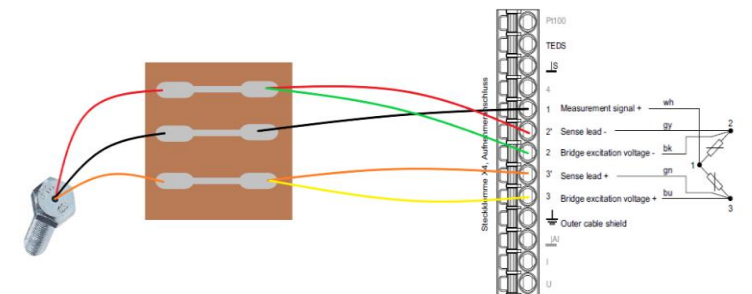
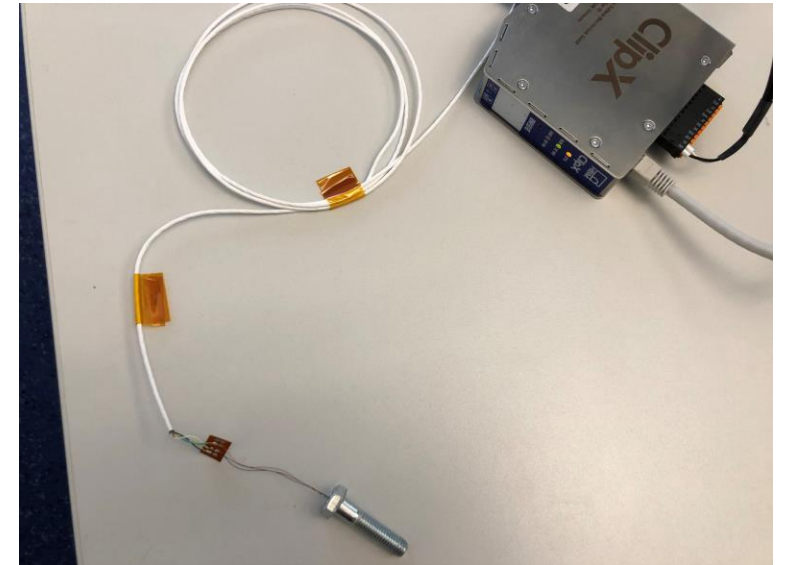
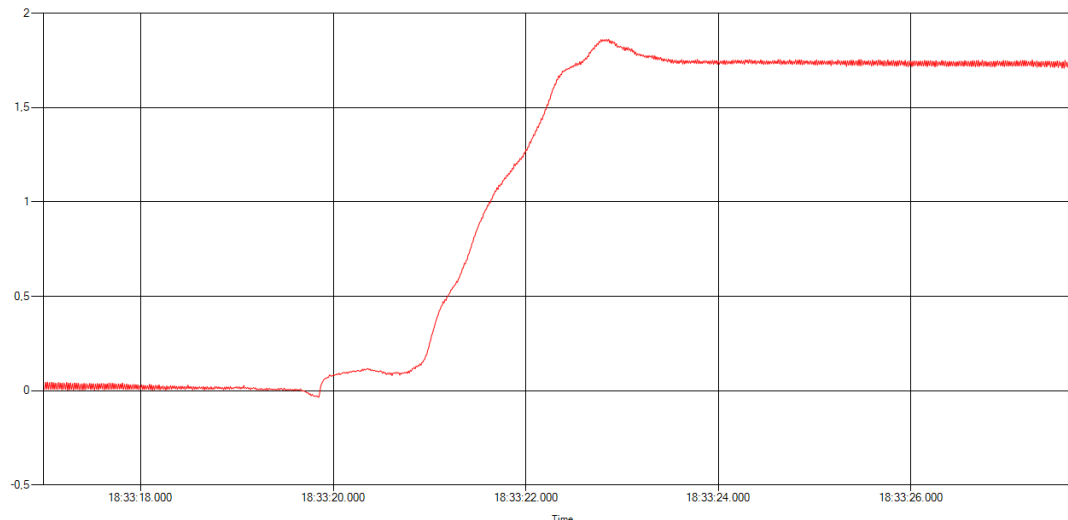


Dynamic loads (vibration)



Where are cylindrical strain gages used?

- Application: Monitoring the preload in a machine
- Connect and operate a TB21 screw with strain gauges with ClipX. The TB21 Screw is used to measure axial forces, strain and vibration caused by dynamic loads in the machine



How do I install these particular strain gauges?

What is needed?

- 1-EP70 special adhesive
- Cylindrical gauges: LB11 or TB11
- Accessories: RMS cleaning agent, tweezers, scissors, syringe, gloves, oven



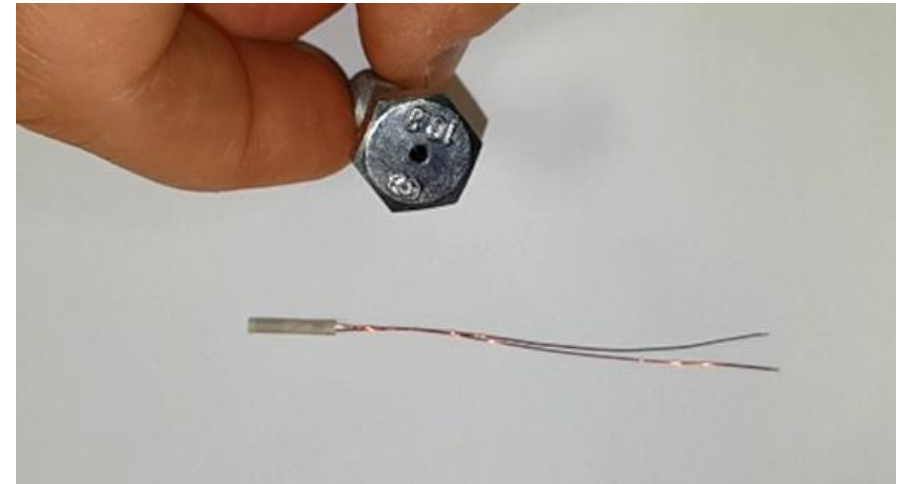
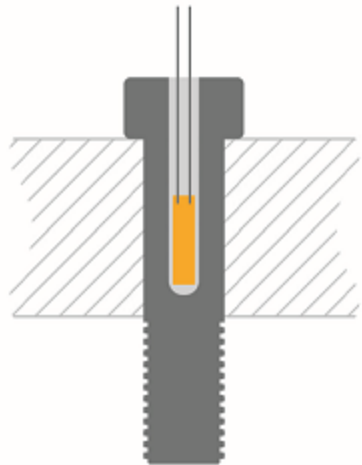
EP70 specifications:

- **Application temperature range:**
 - 40°C up to 70°C
- **Curing temperature:** 3h at 60°C
- **Optional curing step:** If the operating temperature is above 50°C you need to do a second curing step at 100°C for 4h
- **Pot life:** max. 2h after mixing
- **Adhesive is sufficient for 50 installations**

How do I install these particular strain gauges?

Step 1: Drilling a Hole in the Screw

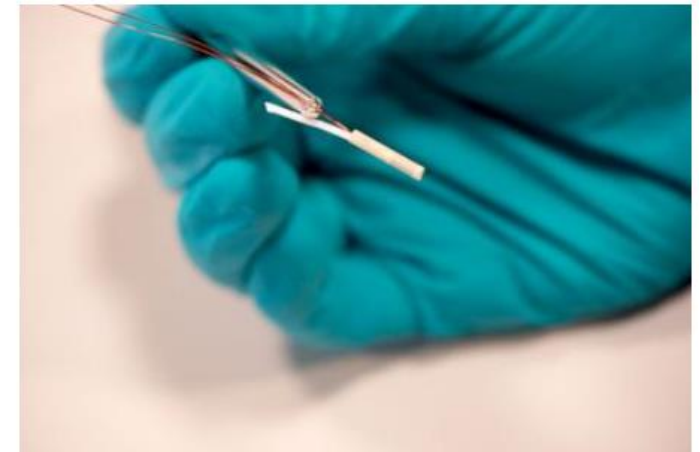
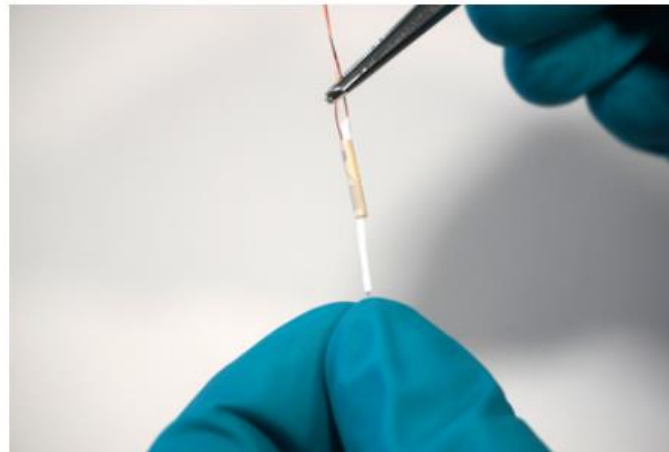
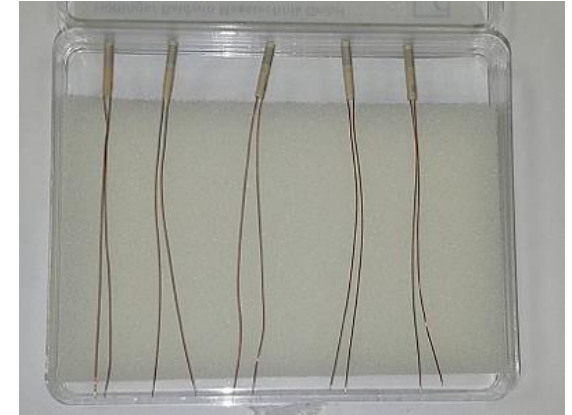
- drill in the center of the screw.
- diameter of 2 mm and an appropriate depth.
- Clean the drilling by spraying RMS 1 (Part number: 1-RMS1 or 1-RMS1-SPRAY), and air dry it afterwards (compressed air can be used as well).



How do I install these particular strain gauges?

Step 2: Preparation of the Strain Gauge

- In the next step, take out one of the strain gauges from its package
- Cut an approximately 20mm long piece of PTFE cord from the supplied roll with scissors.
- Take the strain gauge by the coated copper wires with tweezers and insert the PTFE cord into the cylindrical strain gauge.
- Place the prepared strain gauge on a clean surface.



How do I install these particular strain gauges?

Step 3: Bonding of the Strain Gauge

- Fill a syringe with EP70 (Order number: 1-EP70).
- During all installation steps, the occurrence of air bubbles must be avoided.
- In the next step, fill up the predrilled bolt with the adhesive in the syringe.
- To reduce air bubbles put the syringe tip to the bottom before the insertion of the adhesive. When the hole is filled up, pull out the syringe slowly while refilling with adhesive.
- Insert the strain gauge with the PTFE cord.

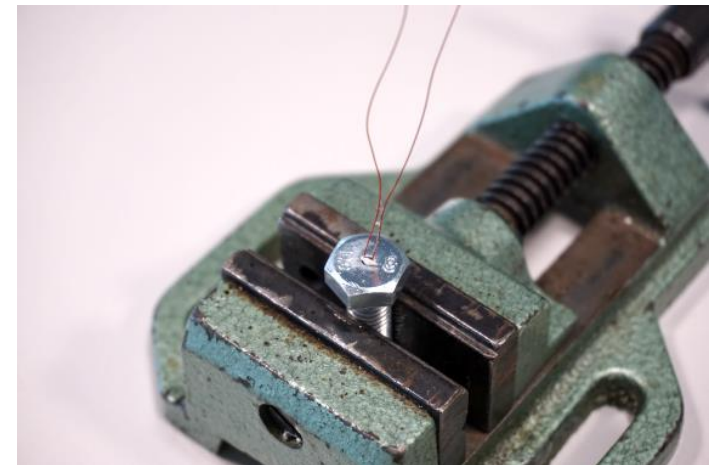
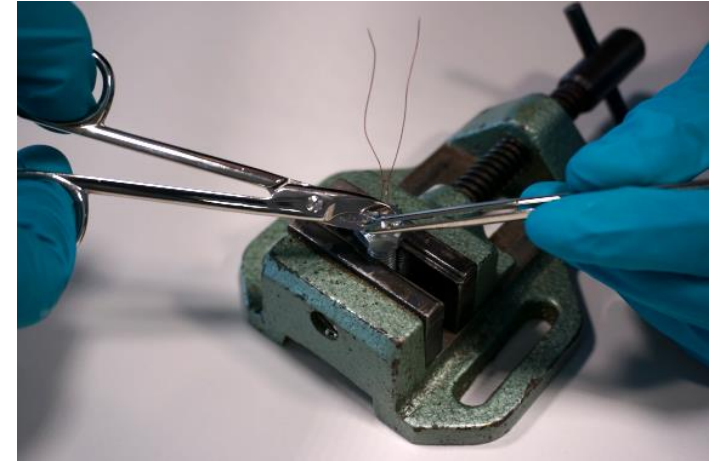


How do I install these particular strain gauges?

Step 4: Curing of the Adhesive

- Cure the adhesive for the specified time in an oven. The curing times of the adhesive are specified in the instruction manual.
- After the adhesive has cured, the PTFE cord can be cut off with scissors. The remaining PTFE cord stays in the installation.

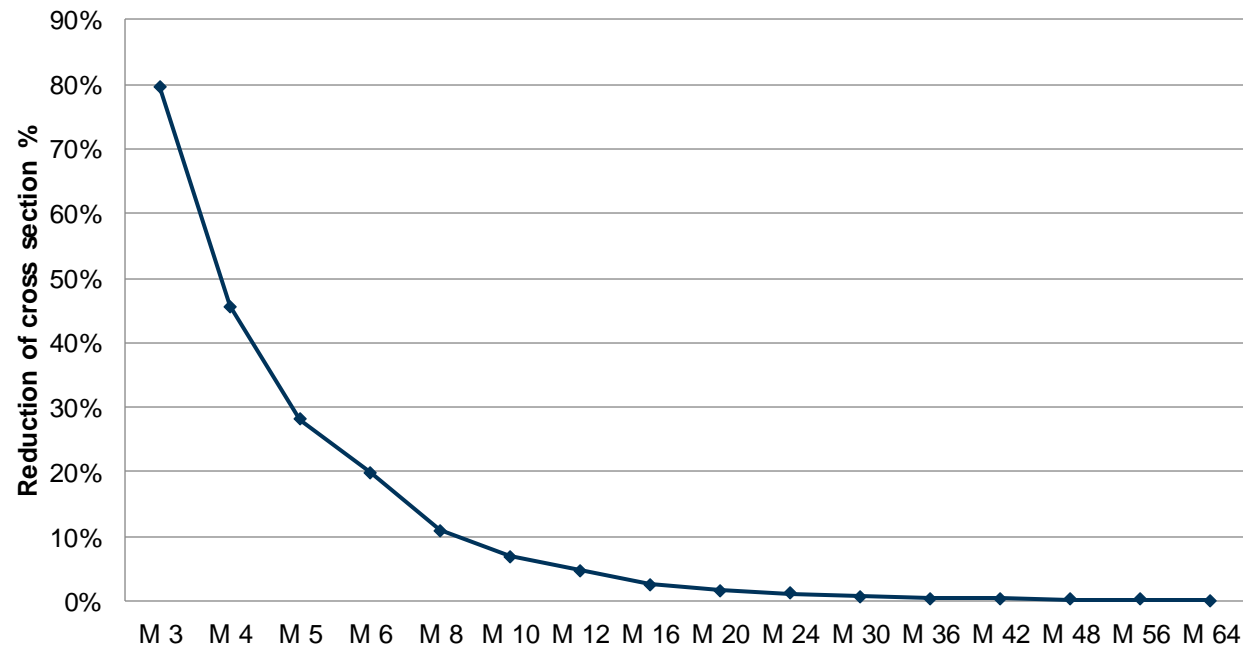
Temperature [°C/°F]	Curing Time
60/140	3 hours
Optional post-curing at 100/212	4 hours



What can I achieve with these strain gages?, where are the limits?

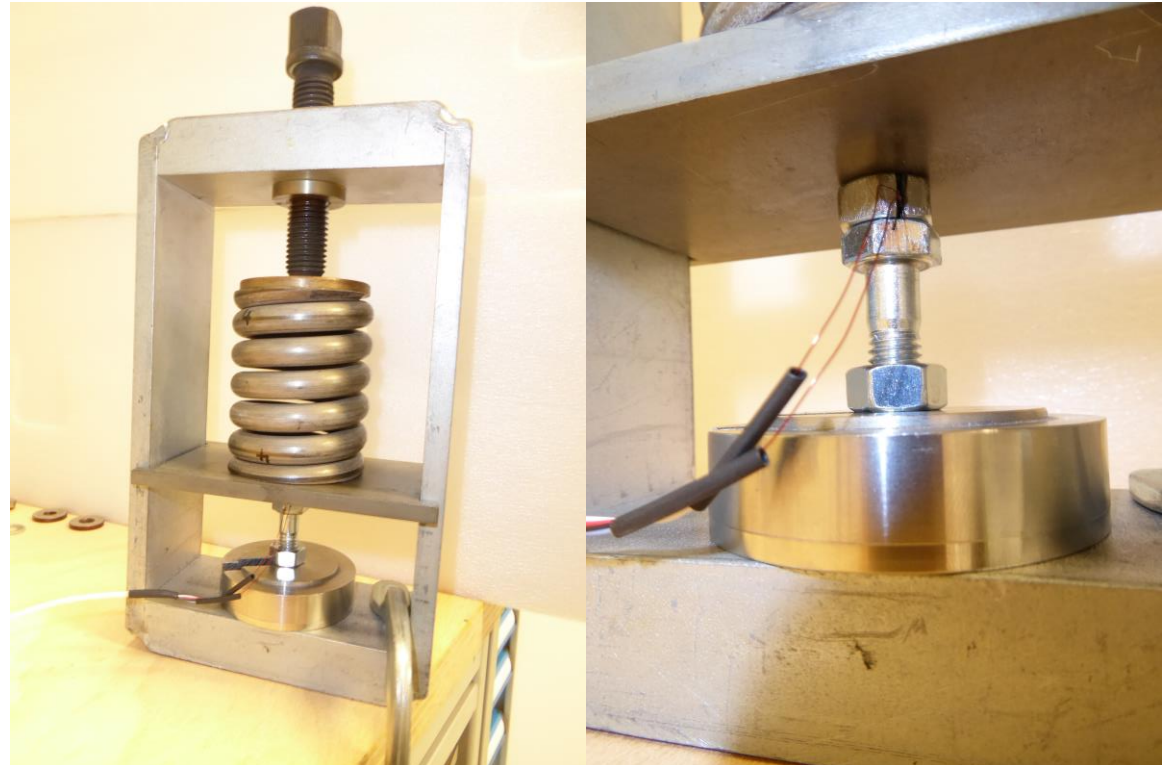
- The screws must have a sufficiently large diameter
 - The screw must not be weakened too much so that it can do its actual job
- There must be sufficient strain. A FE simulation is advisable

Reduction of cross section of screw caused by 2mm drilling



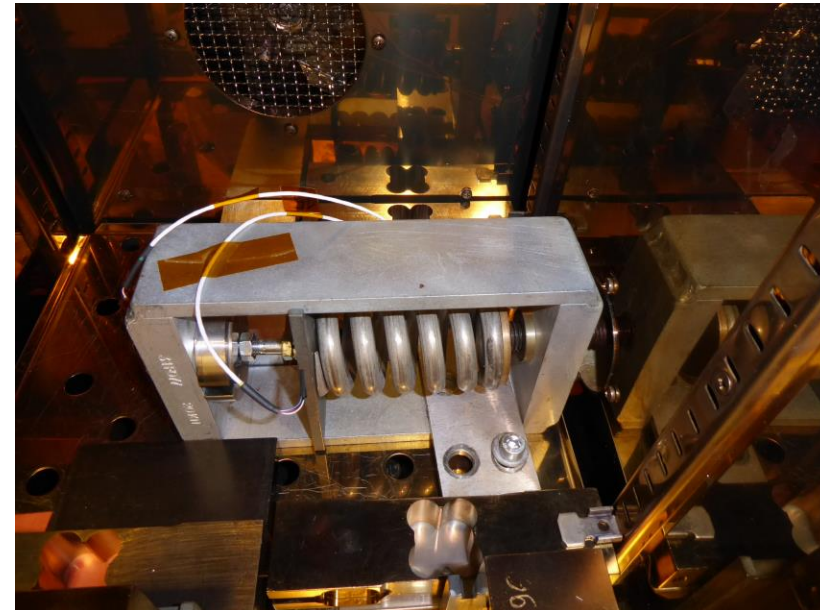
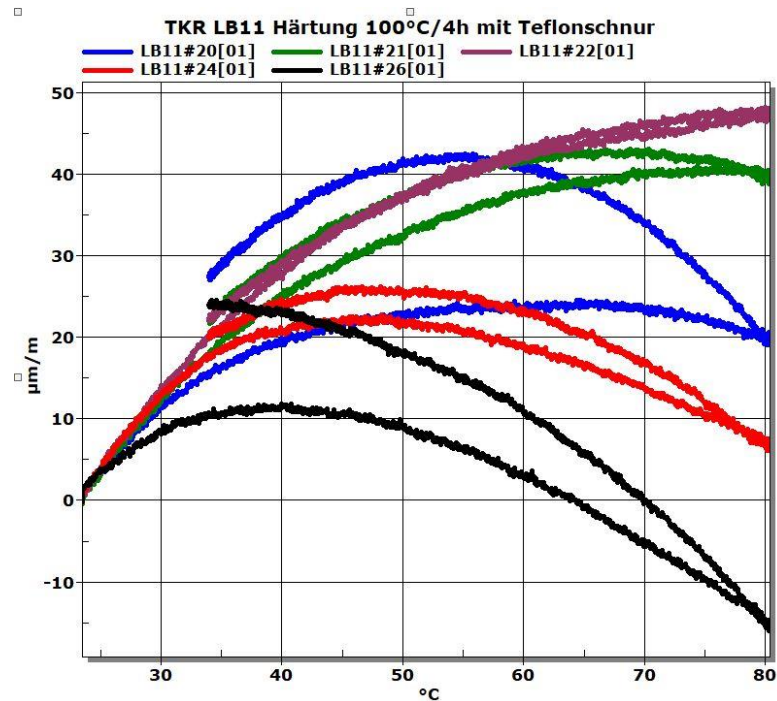
What can I achieve with these strain gages?, where are the limits?

- Screws can be calibrated by means of a reference transducer
 - Tension
 - Compression
- Maximum strain:
 - 2500 $\mu\text{m}/\text{m}$ at 20 °C
 - 2200 $\mu\text{m}/\text{m}$ at 0 °C
- Especially at lower temperatures, the fatigue strength is significantly reduced compared to conventional strain gauges for higher strains.



What can I achieve with these strain gages?, where are the limits?

- Temperature effects behave differently with cylindrical strain gages than with regular strain gages.



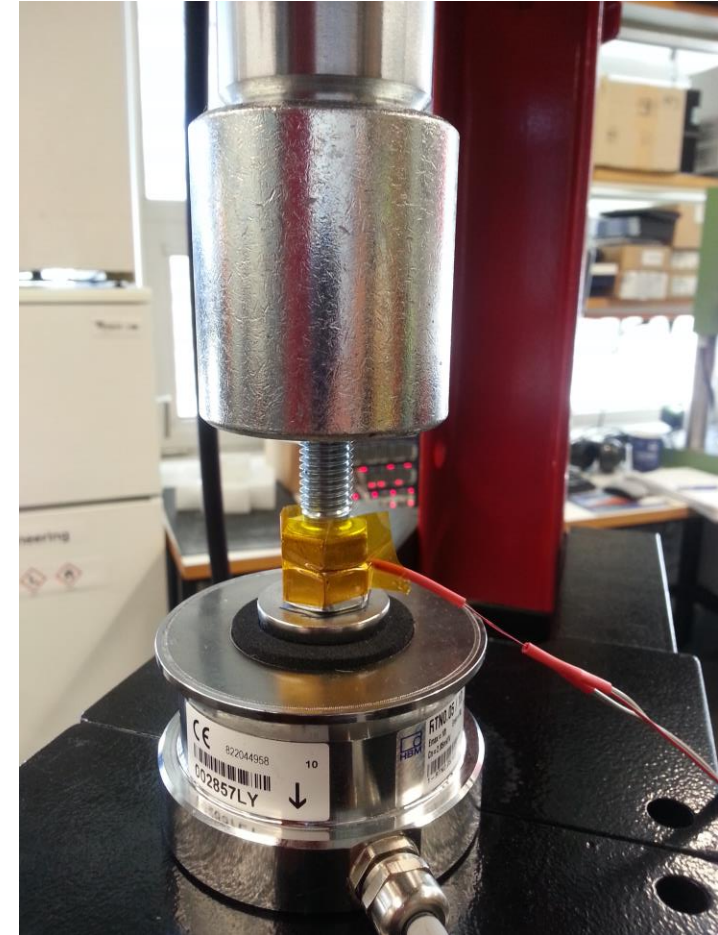
What can I achieve with these strain gages?, where are the limits?

Keep in mind: Measurement with cylindrical strain gages is an alternative to conventional sensors when they cannot be used.

- The accuracy and traceability is lower
- The installation and use is more complex
 - **You build your own sensor**

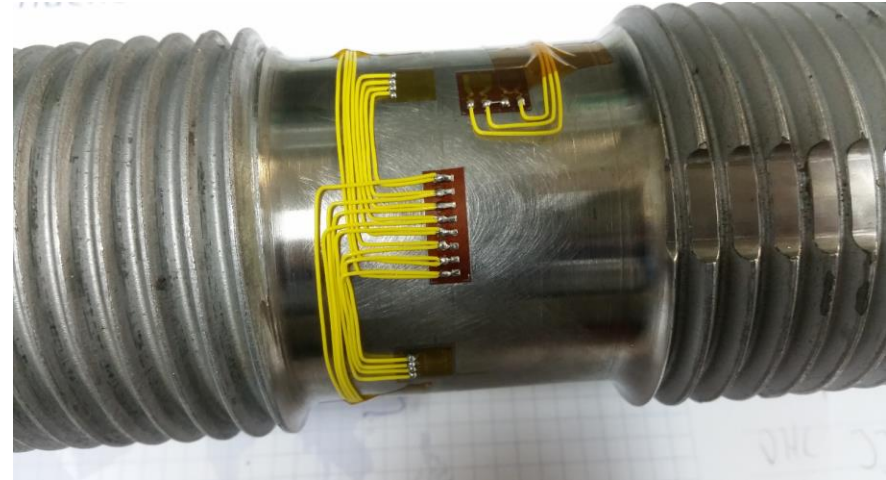
The accuracy to be achieved depends strongly on:

- Maximum elongation in nominal range -> Resolution
- Size and Material of the screw
- Application temperature range (less is better)

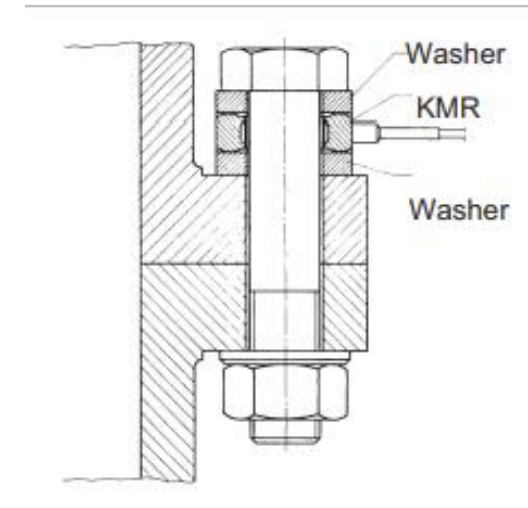


Alternatives

1. Glue strain gauges on the outside of the bolt/stud



2. KMR Force Washer



General strain gauge knowledge database:

www.hbm.com/strain-fundamentals



Product page LB11 and TB11:

[LB11/TB21 Strain Gauges for Measuring in Screws & Bolts \(hbm.com\)](http://LB11/TB21 Strain Gauges for Measuring in Screws & Bolts (hbm.com))



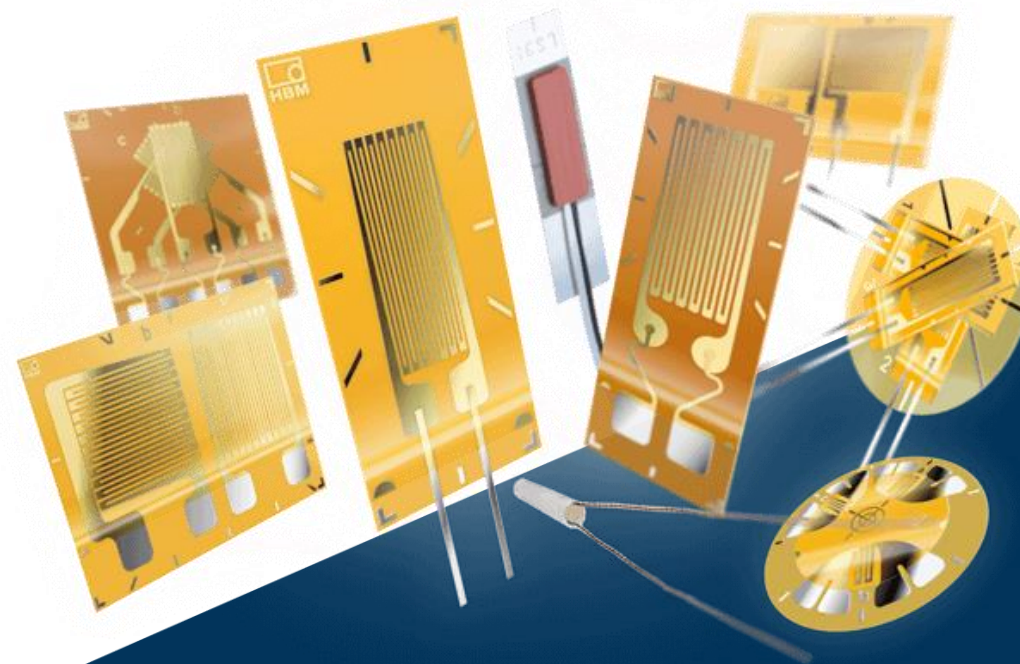
Product page EP70:

EP70 Adhesive for Cylindrical Strain Gauges | HBM



On-site service:

helpme@hbkworl.com



PUBLIC



Questions?

- Please type any questions you have into the WebEx Q&A dialog
- You can open the Q&A window by selecting the “Q&A” icon in the WebEx toolbar at the top of your screen:



- Today’s presentation will be E-mailed to all attendees. The webinar will also be posted on our website: <http://www.hbm.com/en/3157/webinars/>
- If you have additional technical questions, feel free to contact our Americas technical support team at support@usa.hbm.com or the European technical support team at support@hbm.com.



Thank You

HBM Strain Gauges: First Choice for Strain Measurements