Electric Strain Transducers

Measurements of forces and stresses with electric strain transducers at or in structures are based on the fundamental idea to calculate stresses or forces at the structure by the detour of strain measurement. For this purpose the measured strain is multiplied by the modulus of elasticity of the structure. But this is one of the disadvantages of all these procedures. While the electric strain measurement is exact enough, the exact determination of the elasticity modulus - f. e. of concrete - is rather difficult, because it depends on the composition and on the external strain of the concrete, and furthermore because it varies with time. When using this method at steel structures those difficulties can be excluded.

The following components are often used for strain measurements:

- High precise, electric deformation transducers,
- Vibrating wire strain transducers and
- Strain foil gauges.

These strain transducers are used, when the properties of the material where they are embedded or fixed are known. It is advantageous, as for displacement measurements, that the strain transducers have a rather long measuring base when they are used for stress measurements. Thus an integrating effect results that filters a mean representative stress from the often erratic stress values.

When calculating the stress from strain measurements you have always to consider that strains at the test specimen and at the transducer are caused by temperature changes which have nothing to do with the external stresses. Therefore we recommend to measure the temperature at the test specimen and at the transducer or - in case of strain transducers - to make use of circuits that compensate thermal strains. If the temperature changes at the test specimen and at the transducer are known, you can take the influence of the temperature into account when determining the effective strain in consequence of load.

Geotechnisches Ingenieurbüro
Prof. Fecker & Partner GmbH
Am Reutgraben 9 Fon: ++7243/5983-7
D-76275 Ettlingen Fax: ++7243/5983-97

The principle and method for measuring changes in length with vibrating wire instruments was outlined in the introduction to chapter 3.

Specially for taking strain measurements on steel and concrete components and for embedding in concrete we install e. g. strain transducers system Glötzl/Maihak. In addition to measuring displacement or strain, the vibrating wire type of transducer can also be used to measure pressures and stresses or forces.

These instruments display the following characteristics:

- High measuring sensitivity (e. g. 3 x 10^{-4} or 2 x 10^{-3} of the measuring range)
- Possible remote transmission of measured values regardless of changes in resistance on the transmission routes
- Small insulation resistances (starting from 10 kOhms) are sufficient
- Instruments are simple and rugged in design
- Transducers are ready for installation, calibrated and waterproof
- Fully automatic measurement and logging possible

Fig. 1 Measuring sensor GFVM 250/0.5 for concrete strain measurements, based on the vibrating wire measurement process

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The measuring sensor GFVM 250/0.5 (Fig. 1) has a measuring length of 250 mm and is enclosed in a pressure-water-tight capsule. It is particularly well suited for taking measurements in concrete and coarse aggregates.

The sensors are embedded directly in concrete without needing to be surrounded in advance with a protective cylinder. The sensor housings are largely insensitive to bending. The coefficient of thermal expansion of the sensors is roughly equal to that of steel (11.8×10^{-6}). The shielded 2-conductor measuring cable is connected in the required length and sealed with a 2-component casting compound. The measuring wire has additional protection against water ingress.

Vibration wire sensors for welding or screwing in position are available to determine strains on steel component surfaces, e. g. tunnel arches. We have found the GFVM Type C steel strain sensor to be best in this connection. It can be fastened with either four weld-on threaded bolts size M 12 with hexagonal nuts for use on flat steel sections or with two weld-on adapters with four clamping screws size M 12 for use on concave structural steel parts. Its measuring length equals approximately 250 mm with a measuring range of approximately 2000 $\mu\varepsilon$.

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