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## Non-contact Mechanical Tension Measurement in Prestressed Concrete Structures

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### Abstract

INSET company developed a unique measurement system DYNAMAG® which allows non-contact mechanical tension measurement in prestressed steel parts of concrete constructions like beams, plates etc.

Principle of measurement method is based on the magnetoelastic effect of ferromagnetic materials. There is an interaction between the magnetization and the strain of a magnetic material. DYNAMAG® measures the change of relative permeability of the material during its mechanical load.

DYNAMAG is suitable for both checking the quality of prestressing process during construction and for long term monitoring.

Typical applications are:

- in geotechnical structures like tunnels, anchored pile walls, and embankments (tension measurement in ground anchors)
- in bridge structures for monitoring prestressed beams and plates, cable-stayed bridges and extradosed bridges (tension measurement in steel strands, cables and rods)

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*Keywords:* dynamometer; tension measurement; monitoring; ground anchors;

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### 1. INTRODUCTION

Magnetoelastic dynamometer DYNAMAG® allows mechanical tension measurement of ferromagnetic materials. It can be used both for monitoring and diagnostics of the state of prestressed structures like pile walls and prefabricated constructions.

### 2. PRINCIPLE OF MEASUREMENT METHOD

Measurement method is based on the magnetoelastic phenomenon. It measures changes of magnetoelastic characteristics of ferromagnetic materials during their mechanical load (tension, pressure, torsion). The relative permeability  $\mu_r$  depends on the tension force. This relation is obtained by simultaneous measurement in multiple operating points with different magnetic intensities. The inverted characteristic can be directly used for finding the force according to measured value of  $\mu_r$ .

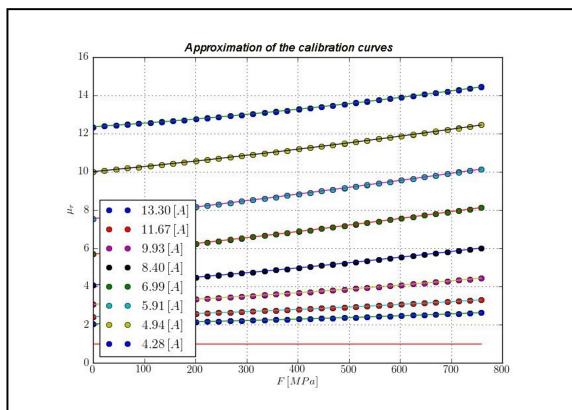


Fig. 1. Dependence: relative permeability/force

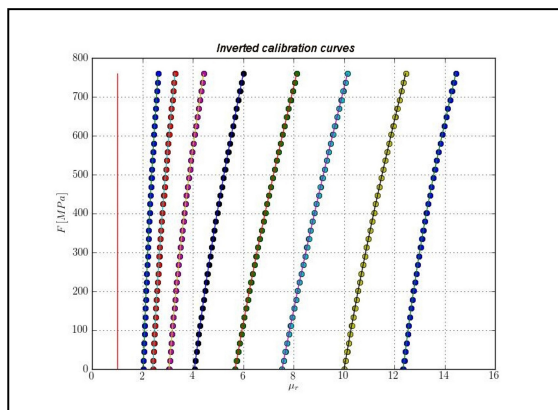


Fig. 2. Dependence: force/relative permeability

### 3. ELEMENTS OF THE MEASUREMENT SYSTEM

**Magnetoelastic sensors** DSCS have shape of hollow cylinder which are installed by sliding onto a measured element (steel strands, cables, rods). They are equipped with an electronic identifier and accurate thermometer. They can be placed on any free parts of prestressed elements or sealed in concrete. They are by default produced in the most used dimensions from 20 mm to 102 mm.

Table 1: Technical parameters

Internal diameter	Length/ External diameter	Measurement range
20 mm	121 mm / 35 mm	max. 300 kN
28 mm	182 mm / 44,5 mm	max. 600 kN
33 mm	182 mm / 54 mm	max. 800 kN
40 mm	220 mm / 63,5 mm	max. 1200 kN
50 mm	220 mm / 76,1 mm	max. 1900 kN
65 mm	260 mm / 88,9 mm	max. 3300 kN
80 mm	260 mm / 108 mm	max. 5000 kN
102 mm	260 mm / 129 mm	max. 8000 kN



Fig.3. Magnetoelastic sensors

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