18ECO134T – Sensors and Transducers

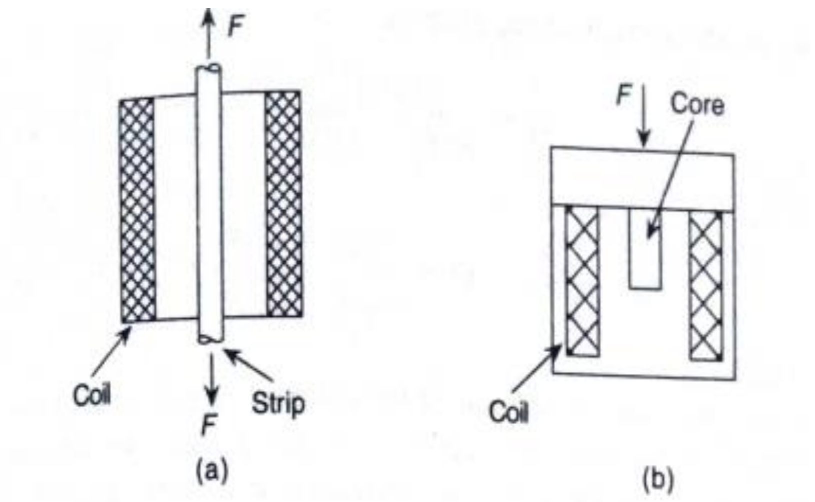
Unit IV : Session 1 : SLO 2

VILLARI EFFECT

- Based on Villari effect, **three basic types** of magnetoelastic sensors may be designed.

TYPE 1:

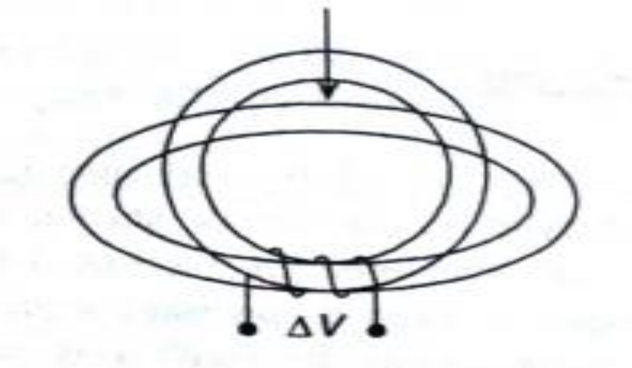
The mechanical loading is unidirectional so as to produce compression or tension and this changes the inductance or permeability with the specimen having predefined magnetic flux path, as in choke or coil type design.



Cont…

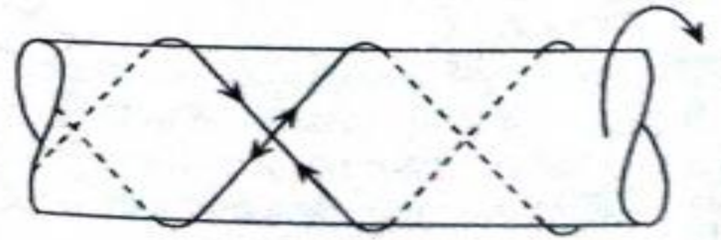
TYPE 2:

- Mechanical loading changes the flux in 2 directions or in a plane as in circular rings or laminated cores.
- Circular ring is deformed into elliptical form and change in inductance of the ring or change in voltage in the secondary winding ΔV gives the value of the load.
- In case of laminated core load cells,



isotropic magnetic materials are used
which becomes anisotropic under stress
due to varying deformation in longitudinal
and transverse directions relative to load
axis and change in voltage can be derived in ring type design.

Cont…



g. 4.8 Stress directions in hollow cylindrical shaft.

TYPE 3:

- Loading changes the flux spatially, that is 3 dimensionally in torque transducers for shafts.
- If the shaft material does not have the requisite magnetic properties such as magnetostriction, an additional magnetic coating on the shaft surface produces the desired mechanical stress on this surface that is to be measured.
- In solid or hollow cylindrical shaft, stress develops in two principal orthogonal directions, one compressive and other tensile, each at angle ±45° with shaft axis in screw like fashion around the shaft (as shown in fig).

- For a hollow shaft of inner and outer diameters Di and Do, the angle of torsion ϕ, the legth of shaft l, torque produced is given by

$$T = \frac{C\pi\phi}{32l}(D_o^4 - D_i^4)$$

The π ximum stress on the surface of the shaft is

$$S_m = \frac{16D_oT}{\pi(D_o^4 - D_i^4)}$$

and maximum strain ε_m is

$$\varepsilon_m = \frac{S_m}{Y}(1 + \nu) = \frac{16D_o(1 + \nu)}{\pi(D_o^4 - D_i^4)Y}T$$

where ν = Poisson ratio.