Strain monitoring of smart concrete cylinders with overwrap composite materials using fibre optic sensors

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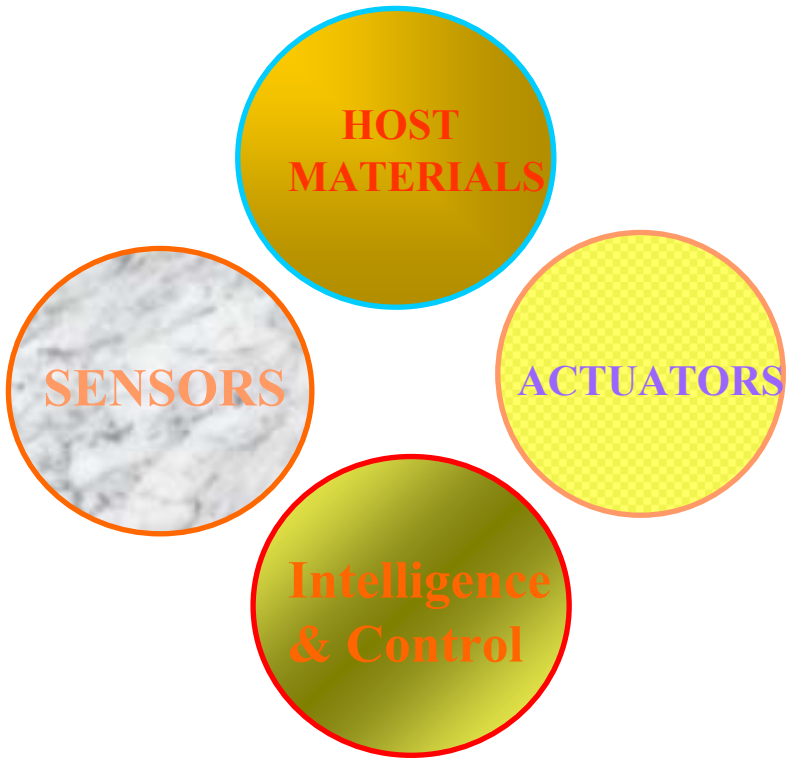
Smart Materials and Structures



- ✧ SENSORS - Fibre Optic and Piezoelectric
- ✧ ACTUATORS - SMA , ER/MR Fluids, Piezoceramics, Magnetostrictors
- ✧ INTELLIGANCE&CONTROL - Neural Network, Fuzzy logic, Condition Monitoring

Applications of Smart Composite Structures

Fibre Optic Sensors (FOS)

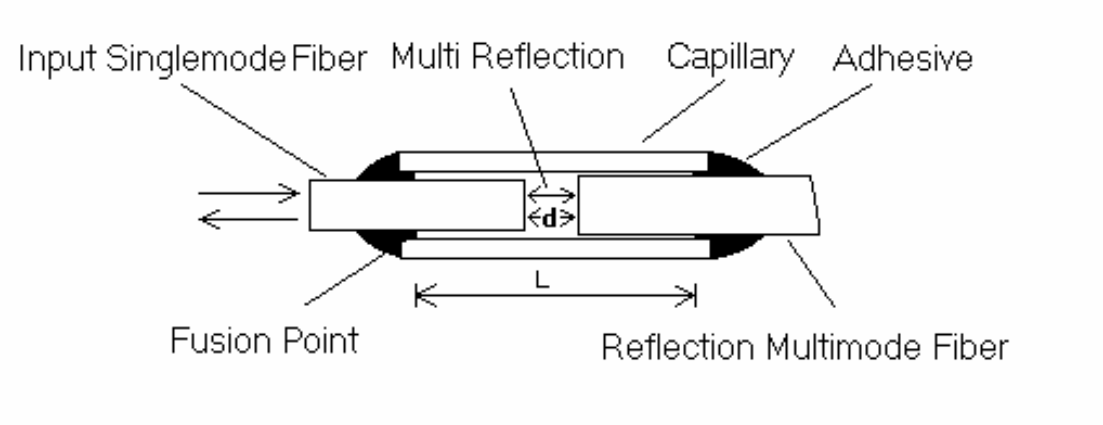
Advantages:

- Immunity from EMI and noise
- Small size and light weight
- Corrosion resistance, geometrical flexibility
- Can be embedded in composite structures in a nonobtrusive manner that does not degrade structural integrity
- Can be distributed sensing using just one single fibre
- Can be sensing the inside parameters of structures

Types:

- Extrinsic Fabry-Perot interferometric (EFPI) sensors
- Fibre Bragg Grating (FBG) sensors
- Multimode FOS
- Polarization FOS
- OTDR/OFDR

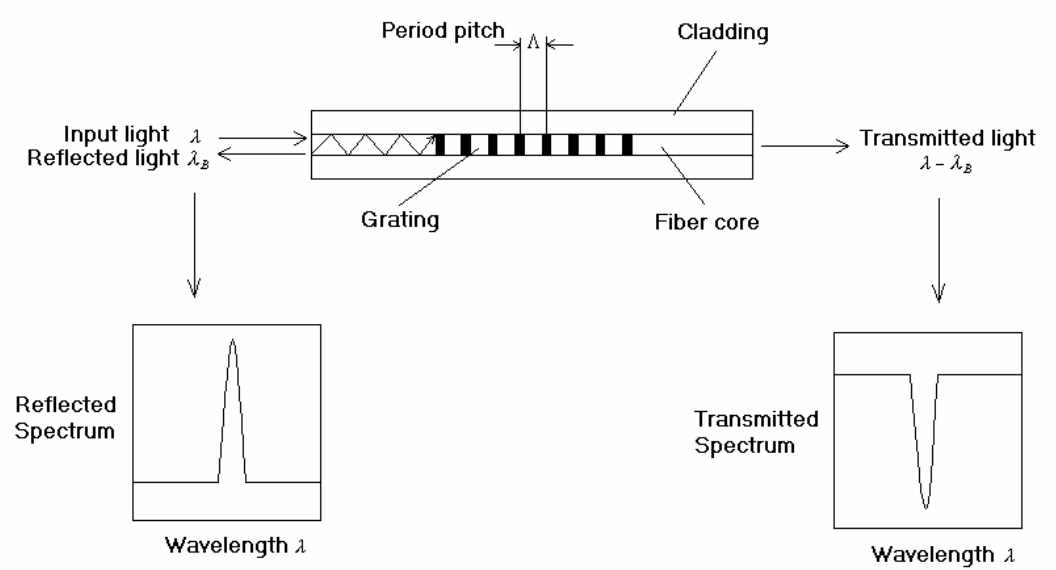
Extrinsic Fabry-Perot interferometric (EFPI) sensors



$$d = \frac{m\lambda_1\lambda_2}{2(\lambda_2 - \lambda_1)}$$

$$\varepsilon = \frac{\Delta d}{L}$$

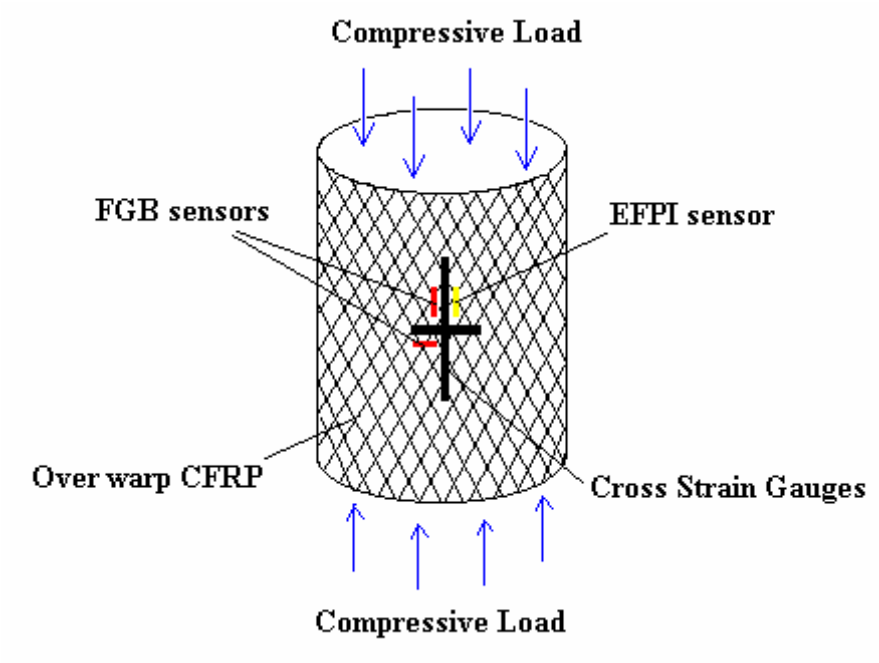
Fibre Bragg Grating (FBG) sensors



$$\lambda_B = 2n_{eff}\Lambda$$

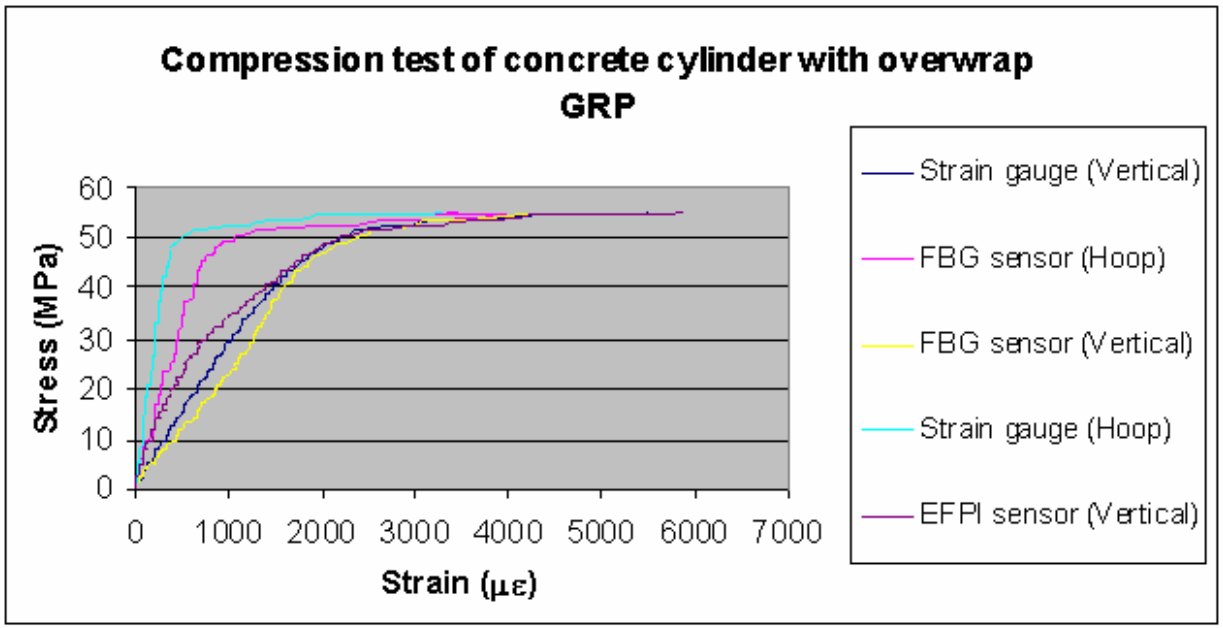
$$\Delta\lambda_B = \alpha\Delta\varepsilon + \beta\Delta T$$

Schematic illustration of GRP wrapped concrete cylinder with FOSs and strain gauges

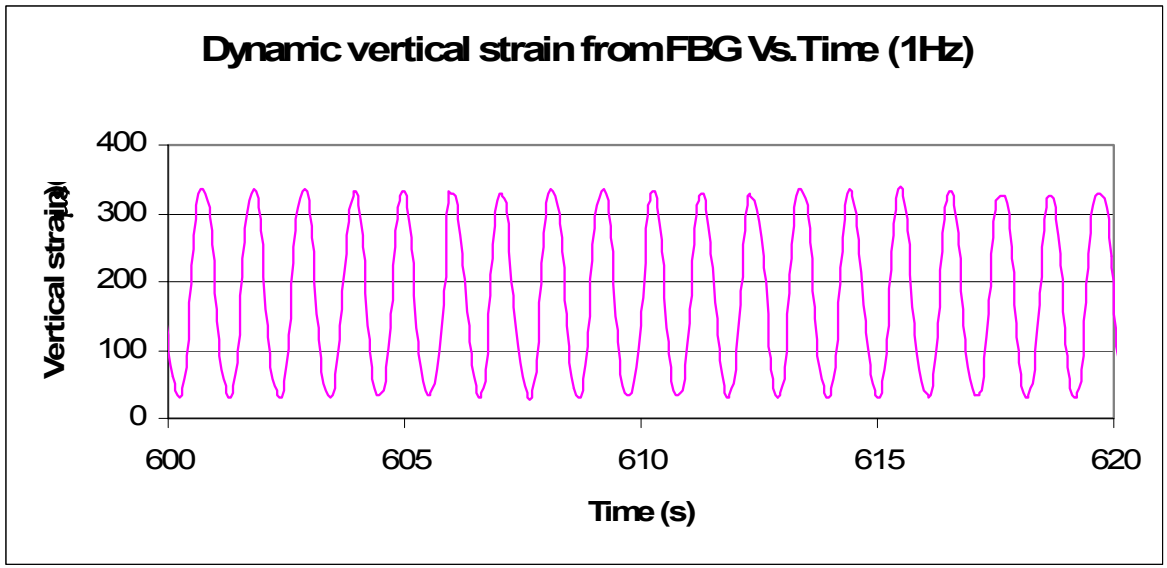


Compression test of GRP composite wrapped concrete cylinder with embedded EFPI and FBG sensors

Static compression results of concrete cylinder with overwrap GRP composites uisng FOSs and strain gauges



Dynamic measurement results using FBG sensor



Conclusions

- **FOS can be used to monitor the static and dynamic strain of concrete cylinders with GRP overwrap composite materials**
- **FOS also can monitoring the structural health status of ageing concrete structures**
- **Smart materials and structures have good potential application prospect especially in the civil engineering , aeronautic, astronautic, automobile, etc..**