Septopod

// Septopod sensor for profiling corrosion activity of concrete cover *in situ*

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Septopod sensor provides long-term information on the performance of cover zone of concrete without causing damage. Its unique combination of sensors enables the monitoring of corrosion activity, electrical resistivity or conductivity, moisture and temperature changes in the cover-zone of reinforced concrete structures.

Septopod can monitor changes in cover concrete as well as reinforcement.

Septopod

- Based on **smart sensor** concept - integration of a variety of sensor techniques in a compact design
- Monitors initiation and propagation of corrosion activity in cover zone of reinforced concrete structures
- Enables spatial and temporal distribution of electrical resistivity and temperature within the cover zone of concrete to be monitored
- Easy to install, robust and compact sensors for long-term monitoring applications
- High performance data logger with a LCD display and data storage
- Simultaneously monitors multiple sensor probes placed at different locations in a structure using a single logger attached to a multiplexer unit
- Comprehensive and easy to use software configuration via Resist
- WI-FI networking/telemetry systems enables easy access to the data remotely
- Stand alone systems can be solar powered

BACKGROUND

When reinforced concrete structures are exposed to extreme environmental conditions they deteriorate at an alarming rate. Therefore, repair and rehabilitation costs of structures far exceed the total budget for capital development programmes. The issue with most structures is not if maintenance is required, but when and where to schedule it most cost-effectively. Therefore, in order to maintain the serviceability of concrete structures it is essential to monitor the performance of structures continuously at three different stages during their service life, viz. initial stage where material properties of concrete change, second and crucial stage where deterioration is initiated and third stage where propagation of deterioration takes place. Smart structures – structures incorporating in their design sensor elements and actuating devices which not only diagnose a problem but affect a solution to the problem – are a new approach for the diagnosis of faults and incipient failures and enable scheduling maintenance effort most effectively and at optimum cost, minimising the possibility of catastrophic failure

SEPTOPOD APPLICATION AREAS

- Lifetime durability monitoring of concrete structures
- Determinatio of time dependent resistance of concrete cover against the ingress of deleterious substances from environment
- Monitoring initiation and propagation of corrosion activity in reinforced concrete structures
- Measurement of corrosion rate of steel in concrete
- Prediction of chloride induced corrosion of steel in concrete
- Monitoring the temperature and moisture changes in response to wetting and drying of cover zone of concrete
- Assessment of the influence of mineral admixtures on durability of concrete structures in service
- Assessment of the protection provided by sealants, coatings and hydrophobic surface treatments against penetration of aggressive substances into the concrete
- Monitoring the early age properties of concrete
- Prediction of service life of structures

Septopod sensor monitoring system at a marine exposure site in Scotland, UK

RANGE OF TESTING

Septopod can be installed in structures at the time of their construction or a miniature version can be retrofitted. Therefore, the structural health monitoring can be carried out continuously.

01 Cover concrete profiling	Crucial data on the performance of concrete cover in relation to its ability to protect reinforcement is obtained
02 Corrosion initiation	Time to initiation of corrosion of steel embedded in concrete is obtained so as to predict service life
03 Corrosion propagation	Rate of corrosion and extent of damage to structures identified and remaining service life is predicted

FEATURES OF SEPTOPOD SENSOR

- Integration of different sensor systems for monitoring initiation and propagation of corrosion activity in reinforced concrete structures
- Monitoring the initiation of corrosion by galvanic current measurements between mild steel anode and stainless steel cathode
- Detects movement of moisture and/or chloride front in the cover zone of concrete using 2-pin electrode array arrangement
- Monitors resistivity or conductivity profile along depth in the cover zone of concrete
- Monitors temperature and moisture variations in the cover zone of concrete
- Capable to monitor four probe resistivity of cover concrete
- Can be used to determine corrosion rate by linear polarisation measurements
- Robust, reliable and easy to install in new constructions
- The Interrogation and data monitoring system has the capability to handle multiple sensor units embedded at different locations in a structure
- Interrogation unit has the ability to store the data and transmit the data using wireless technology
- Simple software to manage the data acquisition

FUNCTIONAL PURPOSE OF SEPTOPOD SENSOR

The Septopod sensor comprises an integration of different sensor techniques engineered into a compact design that can be easily embedded in the cover zone of reinforced concrete. The sensor unit consists of 2-pin electrode array to monitor the ingress of moisture and/or chloride front in the cover zone of concrete, thermistors for monitoring the temperature variations along depth in the cover concrete, 4-pin electrodes for measuring the resistivity of concrete and the support structure of the sensor unit consists of mild steel anode – stainless steel cathode arrangement for measuring the corrosion current (Figure 1 below). The unique combinations of different sensor techniques complements each other and form part of an integrated monitoring system to provide the long term performance of reinforced concrete structures from the time concrete is poured. Therefore, any defect in concrete or its performance is identified well before concrete sets, which is continually monitored as the user prefers.

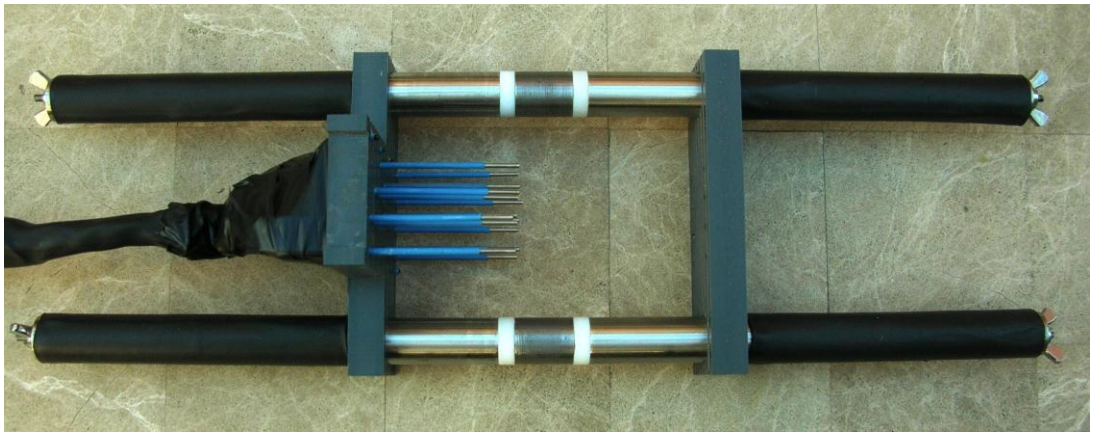

Fig. 1: Septopod sensor

Components of the Septopod sensor system

The Septopod sensor-monitoring system comprises:

- **DATA LOGGER:** High performance and easy to use data acquisition system (Fig. 2a) that operates with 10-30V DC power supply with a 2-line LCD display to indicate logger status. It can be connected to a PC using a RS232 or USB connection. Alternatively a modem can be used for remote operation.
- **MULTIPLEXER**: The multiplexer (Fig. 2b) is connected to the main data logger and is capable of interfacing with 6 Septopod sensor probes simultaneously. The multiplexers can be connected to the mail logger in series with each multiplexer set to a unique address.
- **WI-FI MODEM:** The wireless GSM modem allows simple wireless connection to a PC based TCP/IP network, or to a GSM modem for remote data downloading. This enables global data access and retrieval as well as complete control of the Logger (Fig. 2a).
- **RESIST Software:** The comprehensive software supplied with the monitoring system allows configuring the logger along with multiplexer and Wi-Fi modem. The easy to use Resist software allows download, view and export the data to MS Excel format.

Fig. 2a: Data logger with Wi-Fi Modem and power supply using battery

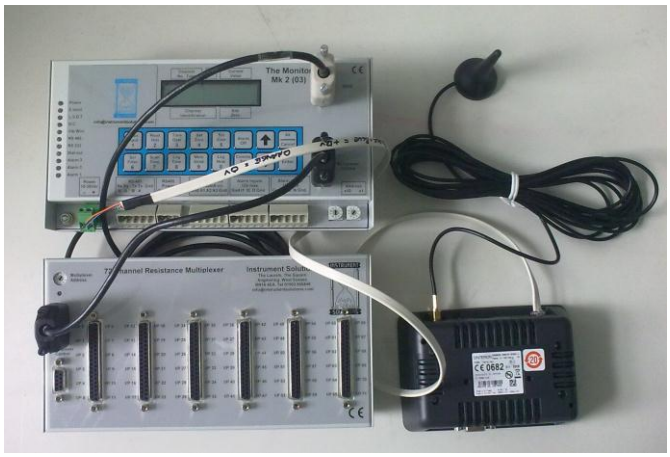

Fig. 2b Data logger with Multiplexer and Wi-Fi Modem

System specification

Power supply	:	10-30 v DC
Operating temperature	:	-10 to 50 °C
Standard range for Electrical resistance	:	0 to 1500000 ohms
Standard range for thermistor	:	-80 °C to +150 °C

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