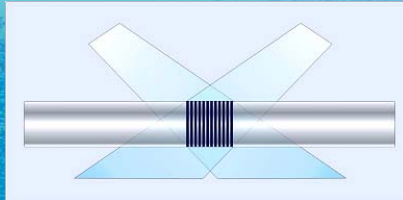
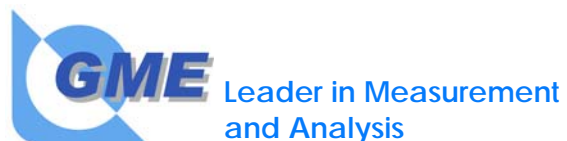


# *HULL STRESS MONITORING SYSTEM*

Fiber Optic Sensors' Solution



**Measure Stresses, Torsion  
caused by Waves,  
Cargo Operation and Motion**



**Global Maritime Engineering**

# HSMSFO - Hull Stress Monitoring System Fiber Optic Sensors'

HSMSFO is to monitor a behavior of hull girder during navigation, loading, unloading, and to provide real-time information on stress level due to longitudinal bending moment and acceleration level due to ship's motion.

The system will give warning when stress and bending moment levels and acceleration of ship motion approach levels which require corrective action escaping the area or reduce

In addition, the information on the navigational condition and environments is provided from the GPS, and navigation equipment etc.

The new fiber optic technology allows any number of sensors to be fitted anywhere in the ship's hull for uninterrupted recordings of actual degree of stress.

Major class notation of ABS, BV, DNV, LRS etc is available.

## FEATURES

- No need to recalibrate sensors ever by zero drift
- No electrical power at sensors - Intrinsically safe
- Sensors immune to electromagnetic radiation and no download effects
- Long-term stability and durability
- In-built temperature compensation available

## BENEFITS

- Prolonged vessel life by reductions of structural damage and fatigue cracking
- Early warning to avoid non-recoverable structural damage
- Cost reduction in repair and maintenance
- Improvement in ship scheduling and optimization of voyage time
- Reduced insurance premiums during vessel's entire life time

## FIBRE OPTIC SENSORS



1.5m HSMSFO-LGL Strain Sensor

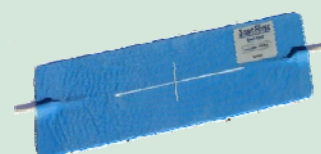
**HSMSFO-LGL** Long gauge length strain sensor comprises two deck fixings which are either bolted or welded to the deck or the inner hull structure.

Between them is a fiber optic sensor assembly which measures the average strain and also temperature for compensation.

A two-way fiber optic cable exits the arrangement from one end. The complete assembly is protected by a cover for LGL or a putting compound for SGL.

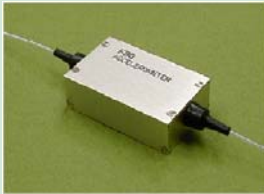
**HSMSFO-SGL** Short gauge length strain sensor is a robust and easy to handle surface bonded strain and temperature sensor embedded within GRP laminate.

It can be applied singly or in multiple HSMSFO-SGL array of single strain sensors, combined strain and temperature sensors and rosette construction for local stress measurement like ice load monitoring.



HSMSFO-SGL Strain Sensor





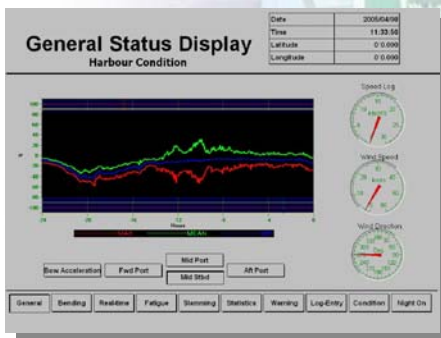
**HSMSFO-ACCEL** and **HSMSFO-PRESS** are fiber optic transducers to measure acceleration and bow slamming pressure. When required, then can be easily added to the strain sensor network and read by the same FBG interrogator.

## FBG INTERROGATOR

FBG Interrogator is used to illuminate the sensor network, read the reflected sensor wavelength and calculate the strains, temperature, acceleration, pressure etc. Various interrogators are available to give the required system performance.



## MONITOR DISPLAY

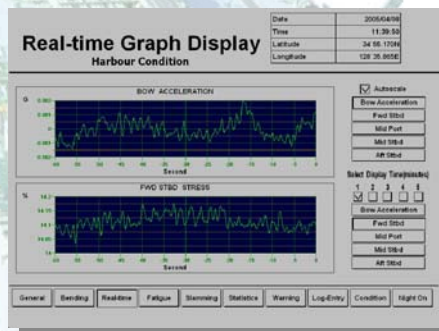


### General Status

Overview screen  
 - mean, max and min values of gauge signals over last 24 hours  
 - percentage values to the prescribed criteria values

### Real-time Display

Display of outputs from each sensor  
 - over last 1~5 minutes



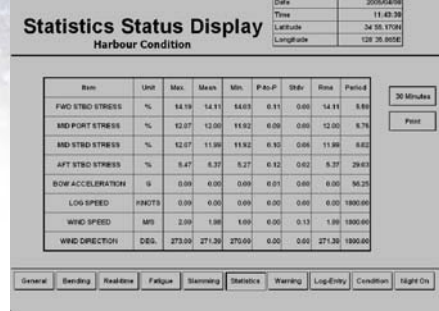
### Statistics

Various statistical property  
 - Maximum +ve and -ve values  
 - Mean value  
 - Maximum peak-to-peak values  
 - Standard deviation  
 - Root Mean Square values  
 - Average zero crossing period



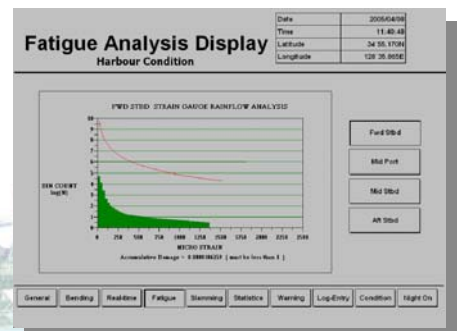
### Bending Moment

Trend of maximum vertical bending moments  
 - over last 1~24 hours for both sea and harbor operating condition  
 - percentage of the prescribed critical values



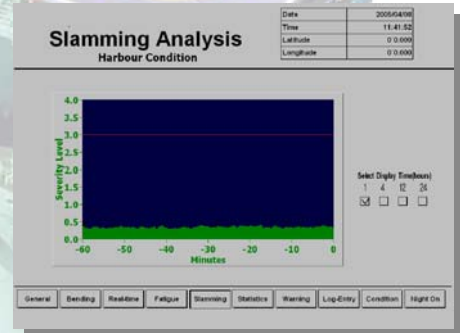
### Alarm History

- displaying the contents of the alarm when the alarm levels are exceeded in some condition



### Fatigue Analysis

Cumulated stress cycle counts  
 - in the whole life of the ship  
 - rainflow analysis for every 25microstrain interval



### Slamming

Trend of slam wave impact  
 - bow acceleration of 2 node component  
 - updating every ten(10) seconds  
 - trend over last 1~24 hours

### Logger Entry display

- acquire a manual entry log of critical data extracted from the ships written log book



## HSMSFO SYSTEM PERFORMANCE

|               | Gauge Length      | Measurement Range   | Resolution       |
|---------------|-------------------|---------------------|------------------|
| HULLFIB-LGL   | Typically 1500 mm | ± 2000 $\mu$ strain | ± 5 $\mu$ strain |
| HULLFIB-SGL   | 20 mm             | ± 9000 $\mu$ strain | ± 5 $\mu$ strain |
| HULLFIB-ACCEL | -                 | ± 2 g               | 0.5% FSR         |
| HULLFIB-PRESS | -                 | Typically 10 bar    | 0.5% FSR         |
| HULLFIB-TEMP  | -                 | -45°C to +85°C      | 0.5°C            |

Custom specifications available upon request

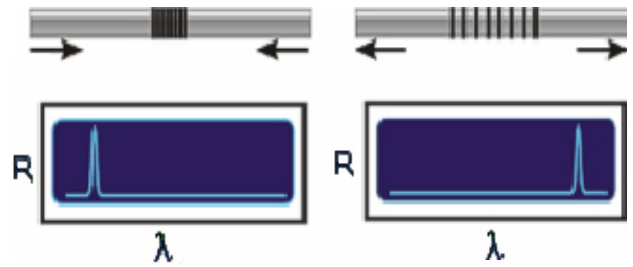
| Interrogator Tech. Spec.  |                    |
|---------------------------|--------------------|
| Number of channels        | 1 or 4             |
| Max sensors/channel       | Typically 12       |
| Update rate (all sensors) | 100 Hz to 1kHz     |
| Interface                 | Ethernet           |
| Dimensions                | 132 x 267 x 135 mm |
| Weight                    | 2.5 kg             |
| Operating temperature     | 0°C to 55°C        |
| Operating humidity        | 0% to 80%          |

## TECHNOLOGY

### Fiber Bragg Gratings

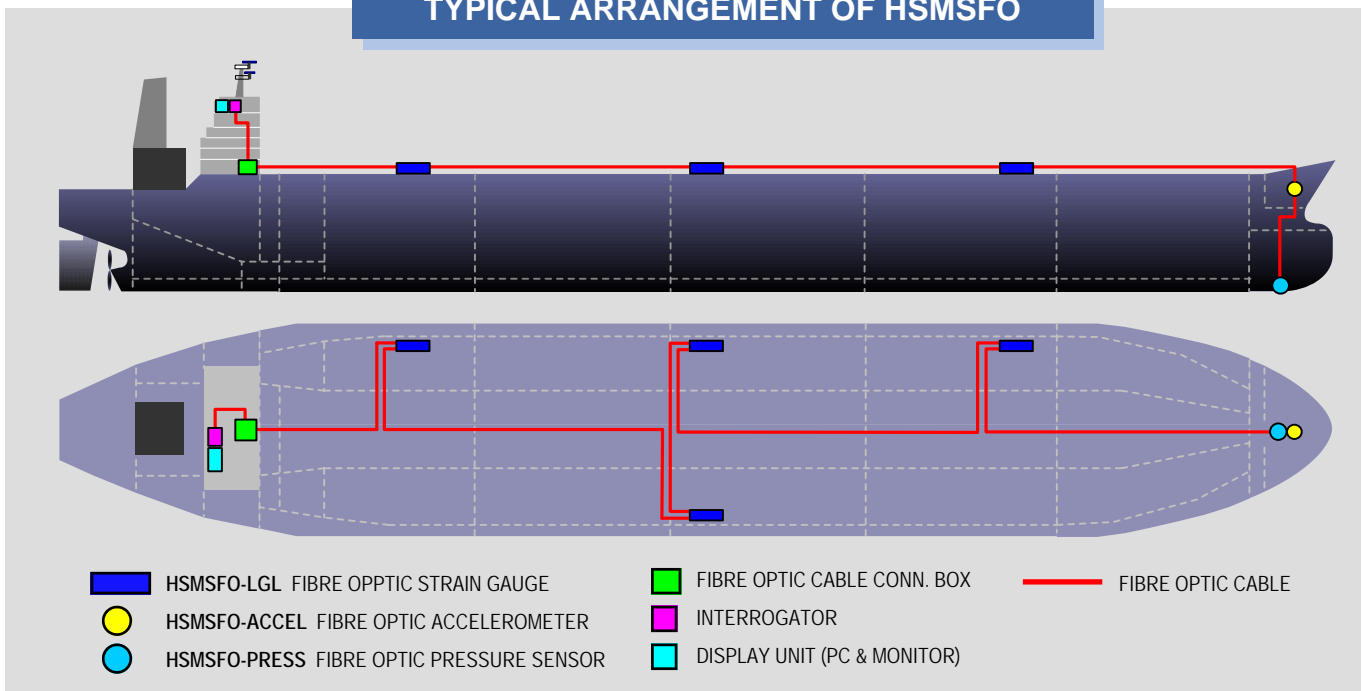
A Fiber Bragg Grating (FBG) is a novel optical sensor recorded within the core of a standard optical fiber. It reflects a narrow bandwidth of light which responds faithfully to changes in temperature and strain.

As well as strain and temperature measurement, FBGs can be used for other measurements such as a single sensor measuring vertical acceleration, a pressure sensor for measuring slamming pressure on the bow bottom.



The diagram above illustrates how the strain applied to a Bragg Grating alters the wavelength of reflected light.

## TYPICAL ARRANGEMENT OF HSMSFO



**Global Maritime Engineering Co.,Ltd.**

78-20, Sandan 7-ro, Jeonggan-eup,  
Gijang-gun, Busan, Korea

Tel : +82 (0)51 265 2001, Fax : +82 (0)51 265 2005

www.gmeng.com E-mail : gme@gmeng.com

