

**FUGRO STRUCTURAL MONITORING
STATEMENT OF QUALIFICATION
ONSHORE SERVICES**



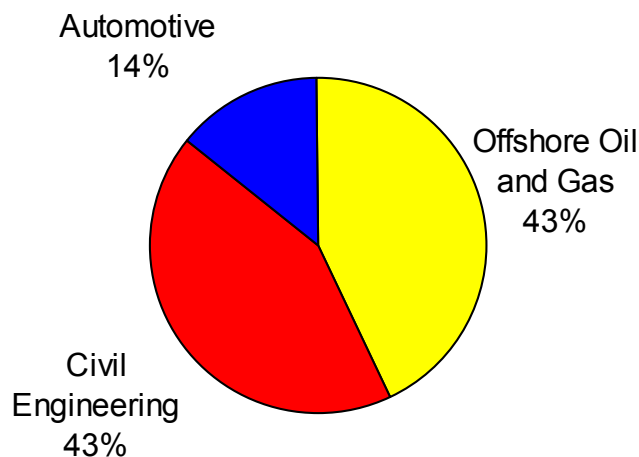


CONTENTS

1.	INTRODUCTION.....	1
2.	ONSHORE MEASUREMENT SERVICES	2
3.	BRIDGE INSTRUMENTATION	3
4.	TUNNEL INSTRUMENTATION.....	5
5.	FIELD TESTING SERVICES	6
	5.1. Services Overview	6
	5.2. Noise and Vibration Services	6
	5.3. Pile Testing Services	6
	5.4. Geophysical Techniques	7

1. INTRODUCTION

- 1.1. Fugro Structural Monitoring (FSM) is an Engineering Consultancy, which undertakes all aspects of measurement, analysis and testing of engineering structures in service.
- 1.2. Instrumentation systems are tailored to client needs to produce data which provides cost effective results. Case histories report savings which amount to forty times the cost of instrumentation systems.
- 1.3. A team of specialists ensures a good understanding of client requirements and proven project management techniques applicable to a wide range of project sizes and documented under the Quality System ISO 9001.
- 1.4. Instrumentation solutions are provided worldwide by co-operation with Fugro resources in onshore, offshore, met-ocean and survey using the Fugro network of over 7,000 staff in over 200 offices world-wide.
- 1.5. The business streams of FSM are summarised below:



- 1.6. This document describes the onshore activities of FSM. Separate documents, describing the offshore and automotive services are available on request.

2. ONSHORE MEASUREMENT SERVICES

2.1. FSM offer a wide range of measurement services which provide a variety of Onshore Industries with cost effective information for:

- Operations Support
- Trouble Shooting
- Certification
- Design Assurance

These services are based on wide experience gained in the Rail, Civil, and Structural industries. This experience is critical to the correct interpretation of data, and result in relevant, practical solutions and recommendations.

FSM Onshore Services can be conveniently classified into the following sectors:

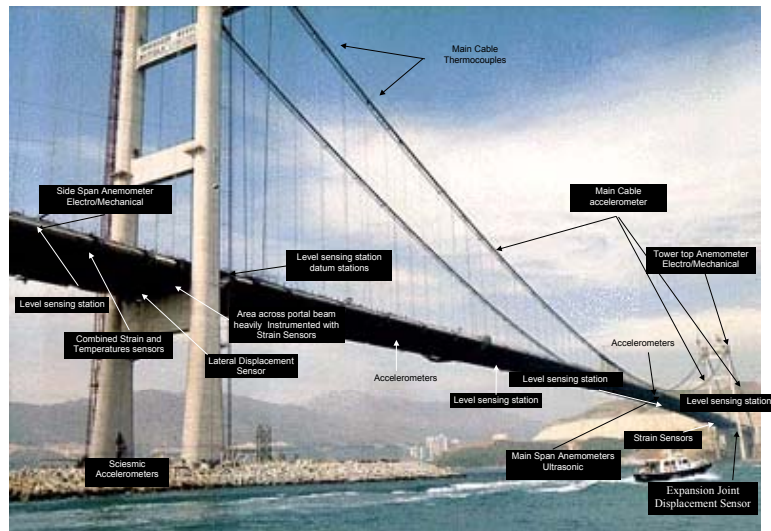
- Structure Instrumentation
- Tunnel Instrumentation
- Field Testing Services



Royal Victoria Dock Footbridge, - Load Monitoring During Construction.

3. BRIDGE INSTRUMENTATION

3.1. FSM have extensive experience in measuring the behaviour of bridges, ranging from small masonry arches to some of the largest suspension bridges in the world. FSM also specialise in the measurement and interpretation of the dynamic behaviour of bridge structures. Services have ranged from simple dynamic measurements on concrete slabs and masonry arches, to extensive instrumentation packages on the three new bridges which comprise the Lantau Fixed Crossing, associated with the new Hong Kong airport. The LFC includes a railway section which was heavily instrumented for fatigue assessment.

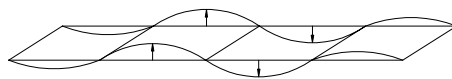


Lantau Fixed Crossing, Tsing Ma Bridge

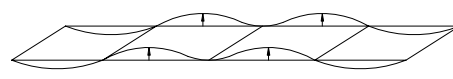
3.2. Examples of the use of bridge instrumentation systems by FSM include:

Department of Transport

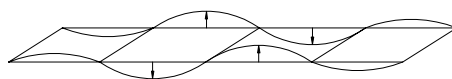
Measurements and modelling of the dynamic response of three types of road bridge for the evaluation of natural frequency monitoring techniques



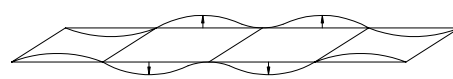
Calculated 4.8 Hz Measured 4.8 Hz



Calculated 7.2 Hz Measured 6.9 Hz



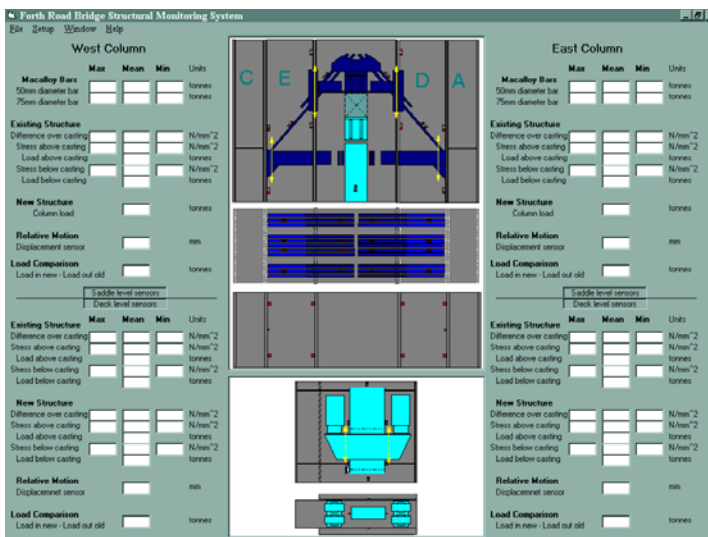
Calculated 6.7 Hz Measured 6.6 Hz



Calculated 8.7 Hz Measured 8.4 Hz

Calculated and Measured Mode Shapes

Railtrack (Scotland)	Development of bridge impact detection system (ongoing).
Hong Kong Highways Department	Extensive instrumentation package on three major bridge structures: Extensive distribution of sensors, a distributed computer network for data acquisition, and an operation, display, and data analysis console.
Kvaerner Cleveland Bridge:	Tamar Bridge: instrumentation including deck profile sensing and cable load monitoring system.
Keir Construction:	Royal Victoria Dock footbridge: load monitoring during installation.
Grootcon:	Forth Road Bridge: monitoring of load and movement changes during jacking operations associated with the tower strengthening works, including real time operator display.
Atelier One:	Dynamic response and load measurements on “ Bridge to Babylon” set structure for Rolling Stones tour.
Flint and Neill:	Erskine Bridge: box section dimension monitoring during and after repairs. Deck profile monitoring system.



5. FIELD TESTING SERVICES

5.1. Services Overview

The field testing department of FSM offers a wide range of testing services. These generally have the characteristics of being short term non-destructive techniques. A speedy response is often required, and services tend to be applicable in areas where access is restricted, such as railways, airports and motorways.

5.2. Noise and Vibration Services

FSM provides a comprehensive range of services to monitor the level of Noise and Vibration for buildings, plant and human comfort assessment. FSM has built up a reputation for good engineering judgement, coupled with analysis and measurement expertise, in serving a range of onshore industries. The division maintains an extensive range of equipment to facilitate on-site measurements, and has developed a wide range of computer software for analysis of noise and vibration data. Services range from rental of simple equipment through to the design and installation of multi-channel systems for long term monitoring.



5.3. Pile Testing Services

FSM offer the full range of pile testing techniques to the piling industry:

Pile integrity testing for cast in situ piles.

Dynamic pile testing for driven piles.

Cross hole sonic logging for large diameter cast in situ piles.

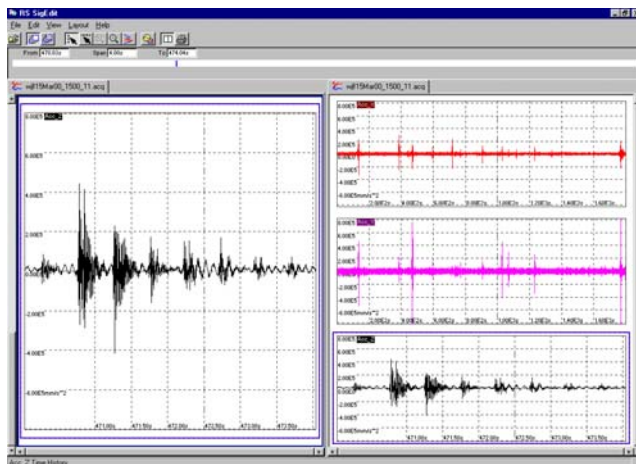


5.4. Geophysical Techniques

Geophysics and structural physics have gained an important role in site assessment and examination because of their ability to provide information in a highly cost effective manner. These are rapid non-intrusive techniques which provide extensive coverage at low cost.

Techniques
Ground Probing Radar
Thermography
Conductivity
Resistivity
Microgravity
Seismic Refraction and Reflection Sonic Pulse
Laser Induced Fluorescence

Applications
Structural Assessment:
Bridges
Buildings
Tunnels
Environmental:
Landfill
Leachate
Underground Fuel Tanks
Geotechnical:
Profiling
Geotechnical Structures
Solution Features
Detection of Voids:
Concealed Mineshafts
Natural Cavities
Old Foundations
Location of Services:
Underground Cables, Pipes etc
Track and Highway Condition:
Ballast Thickness, Void and Defect Detection





FUGRO STRUCTURAL MONITORING

CLIENT LIST

BRIDGE MONITORING PROJECTS

ABB	Lantau Fixed Crossing, Hong Kong Structural Health Monitoring System
AMEC	Erskine Bridge, Glasgow Monitoring during and after structural repairs.
FIFE REGIONAL COUNCIL	Dynamic Response Measurements on Three Concrete Bridges.
FITZPATRICK CONTRACTORS	M1, Junction 2 Bridge Structure In Situ Stress Measurements
FORTH ROAD BRIDGE BOARD	Fatigue Assessment of Bridge Deck (1985-1988): Load Testing of Friction Joints. Measurement of Structural Response to Wind and Temperature. Strain and Rotation Measurement on Deck Truss Links. Assessment of load redistribution around damaged hanger.
GEOCONSULT (ITALY)	Measurement of Response Characteristics, Chiusaforte Bridge.
GROOTCON	Instrumentation during tower jacking project. Forth Road Bridge
HERTFORDSHIRE COUNTY COUNCIL	Cable Tension Measurements on Post-Tensioned Concrete Bridge.
HUMBER BRIDGE BOARD	Estimation of Hanger Tensions. Assessment of Defects. Measurement of Structural Stresses Due to Footpath Loading. Consultancy, Instrumentation Procedures. Fatigue evaluation on expansion joint plates.
KIER CONSTRUCTION	Victoria Dock Footbridge, Load measurements during stay tensioning.



LOTHIAN REGIONAL COUNCIL	Musselburgh By-Pass: Bridge Response Measurements on 7 Structures.
MOTT McDONALD BRIDGES	Hanger Tension Measurement, Tamar Bridge.
SCOTTISH DEVELOPMENT DEPARTMENT	Fatigue Assessment of Deck, Erskine Bridge.
HARRY STANGER LIMITED	Glencoe Bridge Stress Monitoring.
STANGER CONSULTANTS LTD (For Howard Humphreys)	M25, Runnymede Bridge Measurement of In Situ Stress.
TBV STANGER	M8 Bridge Structures M4 Bridges Glenrothes Footbridge In Situ Stress Measurements.
TAYSIDE REGIONAL COUNCIL	Measurement and Analysis on Pedestrian Suspension Bridge. Measurement and Analysis Project on Five Highway Bridges.
TING KAU CONTRACTORS JV	Ting Kau Bridge, Hong Kong Structural Health Monitoring System.
TRRL (RESEARCH PROGRAMME)	Investigation of Vibration Methods for Monitoring - Integrity of Concrete Bridges



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RAILWAY RELATED PROJECTS

SKANSKA	CTRL 230, Stratford Box Instrumentation requirements for Construction Monitoring. Including inclinometers, piezometers, strain gauges, load cells.
CSB JV	CTRL 240, monitoring of the LUL Central Line tunnels, where the CTRL is to cross below the tunnels at Stratford.
Railtrack Scotland	Development and trial of a Bridge Impact Detection System (ongoing)
Halcrow	Vibration Monitoring in Haymarket Tunnel, Edinburgh
Mowlem	WCML, Bridge truss stress measurements, Clyde Bridge
Mott McDonald	WCML, Measurement of dynamic response and deflections (4 bridges).
Highways Agency	Installation of Soundprint monitoring system for post-tensioned Road-over Railway Bridge.
Wrekin Construction	An array of nine triaxial vibration heads connected to a local acquisition unit within a tunnel. Analysis was performed at the local unit and the results displayed in the site office through a 1.5km fibre optic link.
Inverclyde Land and Marine for Railtrack	Abronhill Railway tunnel was monitored as work progressed above to excavate overburden above the tunnel. Vibrating wire strain gauges, thermocouples, and electrolevels were all logged, and transmitted through a serial link to the site offices where the results were displayed.
Ove Arup and Partners	Automated remote crack monitoring, Glasgow Underground
Various	Vibration Monitoring in SPTe Glasgow Underground during excavations, demolition and piling works.
Mowlem Management for Railtrack	Long term monitoring of deflections and stresses in railway tunnel, during reconstruction of the new station in Birkenhead. Noise and vibration monitoring during construction site.
Balfour Beatty	Vibration Monitoring of Queen Street Mainline Station.



Halcrow Crouch	Vibration monitoring of Charring Cross tunnel in Glasgow
Halcrow Waterman	Vibration monitoring of SPTE Underground tunnel in Glasgow
Research Project	Monitoring of Under-track pore pressures.