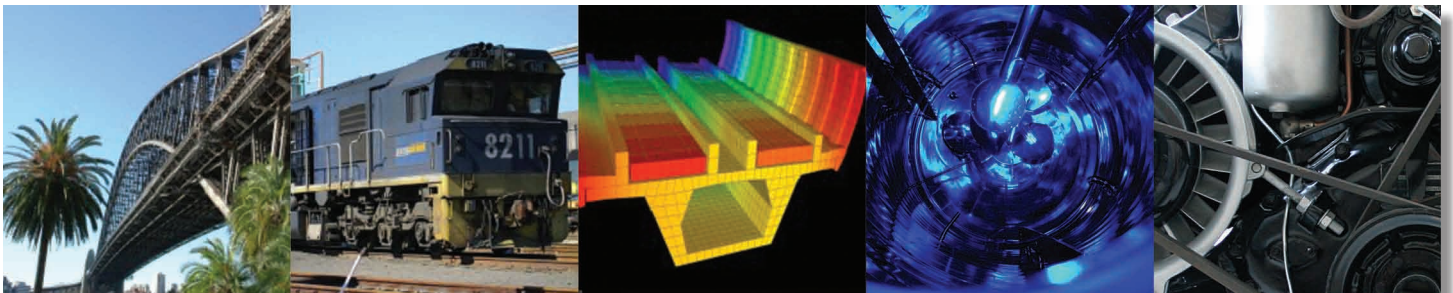


Company Background - Overall Service Capabilities

SLR Heggies is a progressive firm of consulting engineers and scientists providing services in the following specialist engineering and environmental fields:

- **Engineering Sciences – Acoustics – Vibration – Structural Dynamics**
 - Acoustics and Vibration Design for Transportation, Industrial, Building and Construction Projects
 - Structural Dynamics – Experimental Modal Analysis – Strain Gauging – Dynamic FEA
 - Structural Condition Monitoring
 - Wind Engineering – Meteorology – CFD – Natural Ventilation
 - Specialist Building Technologies – Energy – ESD – Reflectivity – Lighting
- **Environmental Sciences – Odour and Air Quality – Soil and Water Quality**
 - Environmental and Quality Management Systems
 - Environmental Monitoring Websites – Public Education and Training Videos
 - Acoustics – Noise and Vibration Assessment and Control
 - Odour and Ambient Air Quality – CO, CO₂, NO_x, SO_x, PAHs, VOCs, Airborne Microbial
 - Hazardous Materials – Asbestos – Heavy Metals – TPH/BTEX PAH etc
 - Contaminated Sites – Fuels Solvents Pesticides – Groundwater Quality
- **OHS and Risk Management Services - Media Services – R & D**
 - Occupational Hygiene – Respirable Dust – SMF – Fumes
 - Confined Spaces – Heat Stress – OHS Management
 - NATA Laboratory – Research and Development Services



Company Expertise in Bridge Dynamics

Over the past several years, SLR Heggies has conducted key bridge projects involving advanced technologies focussing our capability into improving the service life of bridges in Australia. Projects in this field embrace a wide variety of technologies including bridge structural analysis, bridge dynamics, predictive assessments, engineering simulations and field monitoring.

SLR Heggies also has a wide range of equipment for measuring modal response, noise, vibration response, temperature, displacements and stress/strain. Our consultants routinely use the latest software packages for noise modelling, dynamic signal analysis, fatigue and fracture mechanics modelling, computational fluid dynamics, modal analysis and general engineering software.

SLR Heggies offers the following specialist services in Bridge Dynamics:

- Bridge Measurement and Testing
- Expansion Joint Monitoring & Control
- Bridge Dynamics Analysis
- Finite Element Modelling & Fatigue Assessment
- Experimental Modal Analysis
- Vibration Control

Visit us at www.heggies.com or call **1 300 434 443** to find out more.

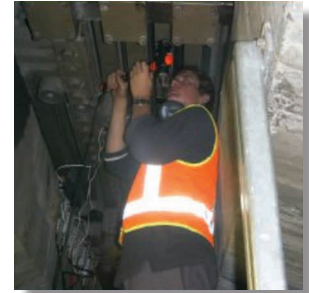
Heggies Pty Ltd is a member of the International SLR Group
www.slrconsulting.com

Particular Capabilities

SLR Heggies are experienced in a wide variety of bridge projects, having accumulated particular expertise in the area of Bridge Dynamics and more advanced applications involving state-of-the-art techniques.

■ Bridge Measurements and Testing

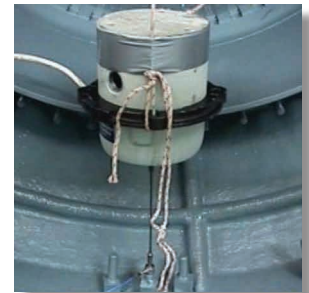
- Strain Gauge Measurement and Analysis
- Shock and Transient Vibration Measurement and Analysis
- Vibration Condition Monitoring
- Multiple-Input Multiple-Outputs (MIMO) Measurements and Analysis
- Large Scale Dynamic Testing and Monitoring
- Extreme Weather Monitoring



Instrument Installation

■ Expansion Joint Monitoring & Control

- Displacements and linear translations
- Strain
- Condition Monitoring of Finger Plate and Modular Expansion Joints via web-based interface



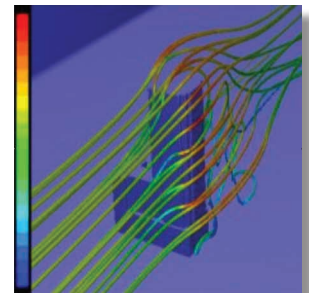
Mini Electro-Dynamic Shaker

■ Bridge Dynamics Analysis

- Stress Analysis and Structural Load Predictions
- Modal, Vibration and Shock Response
- Fatigue Analysis (Miners Rule applied to Random Process)
- Fracture Mechanics – Time to Failure Prediction
- CFD – Computational Fluid Dynamics

■ Finite Element Modelling

- Computer Aided Design (CAD)
- Static/Dynamic Analysis, Stress Analysis, Transient Analysis
- Structural Stiffening, Mass and Damping Modifications
- Fatigue Analysis and Damage Detection
- Thermal, Wind and Earthquake Loading Response Prediction



CFD Velocity Vector Representation

■ Experimental Modal Analysis

- Operating Deflection Shape (ODS) Analysis
- Modal Parameter Identification (mode shape, frequency and damping)
- Impact, Shaker and Operational Modal Testing

■ Vibration Control

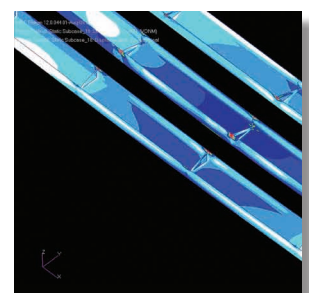
- Dynamic Amplification Factor Characterisation
- Whole Body Vibration Analysis
- Dynamic Absorbers, "Floating" Slabs and Isolated Spaces Design
- Tuned Mass Dampers



Building Isolation

■ Bridges Assessment Specifics

- Mode shape and natural frequency identification
- Dynamic Amplification Factor determination
- Modular expansion joint testing and failure detection
- Thermal deflections
- Strain measurements
- Design Damping for Bridge Oscillations
- Dynamic FEA
- Structure-borne noise radiation
- Fatigue analysis
- Development of Early Warning System for Modular Expansion Joints and Finger Plate Joints
- Design isolation for rail beds (Cologne Eggs) to reduce structure radiated noise



FEA – Bridge Analysis Stress

Recent Projects Undertaken By SLR Heggies

■ Auckland Harbour Bridge

Auckland Harbour Bridge modal analysis and long-term remote monitoring of major vibrational modes of the bridge structure including the definition of natural frequencies and mode shapes. This included:

- Measurement of magnitudes and time history across major bridge expansion joints.
- Correlation of expansion cycles with weather data
- Extrapolation of measured expansion data to maximum weather extremes based on historical weather data.
- Measurement vibration levels
- Analysis of vibration data



Auckland Harbour Bridge

■ Anzac Bridge

SLR Heggies has conducted expansion joint monitoring projects on a number of bridges throughout Australia and New Zealand. One example is the Anzac Bridge where SLR Heggies conducted modular expansion joint failure monitoring to identify the loss of anti-friction bearing supports, which potentially lead to fatigue damage of the modular bridge expansion joint (MBEJ) components and associated safety concerns.

The main system developed (BridgeAlert-M™) detects individual bearing loss and generates an SMS alert signal.

SLR Heggies solution for detecting a bearing loss was to continuously measure the acoustic environment in the void space beneath the MBEJ and monitor the changes in overall noise level and frequency content. The loss of an individual bearing causes the modal response of the MBEJ to change and hence alter the spectral contribution of the noise emissions in the void space.



*ANZAC Bridge
Modular Expansion Joints*

■ Harwood Bridge

Harwood Bridge structure-borne noise abatement project consisted of four major stages:

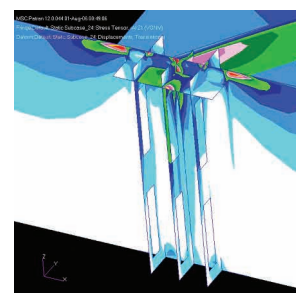
- Stage 1 Design of Replacement bearings / FEA Modelling
- Stage 2 Construction and in-shop testing of high damping bearings
- Stage 3 Installation and test of prototype bearings plus cost benefit analysis
- Stage 4 Installation and test final bearings in all designated approach spans



*Taree Bridge Modular Expansion
Joint Testing*

■ Other Major Projects

- Bridge thermal deflection and measurement of joint movements; a remote monitoring system was developed by SLR Heggies and installed in the vicinity of the major expansion joint on the northern side of the main span. The system has been operating continuously for the period of 10 months and includes rates of change, temperatures and wind speed. The measurements are supplemented with long-term weather data from the Bureau of Meteorology.
- Stress reduction assessments involving analytical modelling of bridge structures using FEA, including static and dynamic analysis as well as modelling of proposed mitigation modifications of damping systems.
- The analysis of the Bascule Spans of bridge structures, including static and dynamic analysis as well as fatigue assessment of high stress areas utilising FEA.
- SLR Heggies is also experienced in associated OH&S projects on large bridges to ameliorate workers conditions via the design of control isolation components to prevent excessive vibration, including lunch rooms for maintenance staff, surveillance cameras and other safety monitoring equipment.
- Brickpit elevated walkway vibration testing to assess walking impact on the bridge's dynamic response.



FEA – Gusset Stress Distributions



Sydney Harbour Bridge

ENVIRONMENTAL SERVICES

ACOUSTICAL DESIGN	<ul style="list-style-type: none"> • REF, EES, EIA, EIS Studies <ul style="list-style-type: none"> - Road, Rail, Aircraft, Industry, Mining • Building Acoustics, BCA compliance • Mechanical Services Noise / Vibration • Construction Noise and Vibration • Environmental Management Plans 	<ul style="list-style-type: none"> • Blast and Explosion Assessment / Control • Silencers, Attenuators, Enclosures, etc • Resilient Mounts, Vibration Isolation Mats, Tuned Mass Dampers • Community Liaison, Expert Testimony, Regulatory Authority Meetings
AIR QUALITY	<ul style="list-style-type: none"> • Outdoor & Indoor REF, EES, EIA, EIS Studies <ul style="list-style-type: none"> - Industries, Transportation and other sectors • Atmospheric Dispersion Modelling for All Airborne Pollutants and Odour • Monitoring All Major Air Pollutants / Odours 	<ul style="list-style-type: none"> • Design/Operation of ambient Air Quality Monitoring Networks • Indoor Air Quality, Natural Ventilation • AUSPLUME, TAPM, CALPUFF, ISC3, ADMS3 CALINE4, AERMOD, FLUENT (CFD)
WATER QUALITY	<ul style="list-style-type: none"> • Water Quality Monitoring 	<ul style="list-style-type: none"> • Ground Water Sampling
HAZARDOUS MATERIALS	<ul style="list-style-type: none"> • Asbestos: Identification, Monitoring, Fibre Counting, Management, Training 	<ul style="list-style-type: none"> • Contaminated Site Investigations & Surveys; Due Diligence Surveys
SITE CONTAMINATION	<ul style="list-style-type: none"> • Monitoring for Lead, PCBs, Silica, SMFs <ul style="list-style-type: none"> - All Major Contaminants 	<ul style="list-style-type: none"> • Remediation Action Plans, Remediation Management, Validation Surveys
METEOROLOGY and CLIMATE	<ul style="list-style-type: none"> • Monitoring for a Wide Range of Meteorological Parameters 	<ul style="list-style-type: none"> • Wind Climate Analysis, Extreme Climate Risk Assessments

ENGINEERING SCIENCE SERVICES

WIND ENGINEERING and CFD	<ul style="list-style-type: none"> • Wind Tunnel Testing and Expert Opinion • Full-Scale Testing of Buildings, Bridges 	<ul style="list-style-type: none"> • CFD Simulations Using FLUENT • Natural Ventilation, Indoor Air Quality
SOLAR – ESD ENERGY STUDIES	<ul style="list-style-type: none"> • Energy Efficiency, Energy Audits • ESD, Sustainability Studies • Shadows, Solar Ingress, Reflectivity • Natural Lighting / Lux Level Simulations 	<ul style="list-style-type: none"> • Energy Ratings – NatHERS, BERS, FirstRate, BASIX, AccuRate (Residential Buildings) • ABGR / GreenStar (Commercial Buildings) • BCA Section J Assessments
STRUCTURAL DYNAMICS and MECHANICAL DESIGN	<ul style="list-style-type: none"> • Experimental Modal Analysis • Dynamic Finite Element Analysis • Machine Vibration Surveys • Turbine Dynamics and Monitoring • Vibration Isolation Systems 	<ul style="list-style-type: none"> • Pipe / Pulsation Analysis (PULS) • Pipeline / Valve Acoustic Induced Vibration • Fatigue / Fracture / Stress Analysis • Mechanical Systems Design • ProEngineer, NASTRAN, FLUENT
ADVANCED SYSTEMS	<ul style="list-style-type: none"> • UAV and Aeronautical Studies • Safety MIL-STD 882 and Risk Engineering • Communications • AEO & AMO Certification Systems 	<ul style="list-style-type: none"> • GIS Management/Assessments • Blast Systems & Modelling • Harsh Environments – MIL-STD 810 • EMC Mil-Std 461

OTHER SERVICES

OHS and OCCUPATIONAL HYGIENE PROJECT and RISK MANAGEMENT	<ul style="list-style-type: none"> • (Certified) OHS Surveys, Audits • Technical Due Diligence Surveys • Ergonomic and Workplace Assessments • Project Management Services 	<ul style="list-style-type: none"> • OHS Management Systems and Training • RF Accumulation & Testing • Risk Studies to AS / NZS 4360 and SAFETY • Health and Toxicology Studies
LABORATORY and R&D SERVICES	<ul style="list-style-type: none"> • NATA-Accredited to ISO 17025 <ul style="list-style-type: none"> - Air Volume Sampling, Asbestos Fibre Counting, Asbestos Identification • Research and Development 	<ul style="list-style-type: none"> • Laboratory and Field Testing for Air and Water Quality, Acoustics, Vibration • Harsh Environment – MIL-STD 810, DEF(AUST) 5168, DEF(AUST) 5681
WEBSITE and MEDIA SERVICES	<ul style="list-style-type: none"> • Web-based Real-time Data Management and Monitoring Interfaces 	<ul style="list-style-type: none"> • Professional Videos for Training, Expert Testimony, Media Presentations