

Robert E. Melchers

BE (Hons I), MEngSc, Dip Ed (Monash), PhD (Cambridge)

Fellow, Australian Academy of Technological Sciences and Engineering
Fellow, Institution of Engineers, Australia
Fellow, Institution of Civil Engineers, London

Professor of Civil Engineering, The University of Newcastle [1986-]
Australian Research Council Professorial Fellow [2004-8, 2009-13]

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Advisory Committee Appointments:

- Nuclear Safety Committee, Australian Radiation Protection and Nuclear Safety Authority (Federal Government regulator) (Ministerial appointment) [2000-]
- Independent Technical Review Committee, Collins Class submarines – Dept of Defence [2002-2003].
- Technical Review Committee for Probabilistic Risk Assessment and Remaining Life Study of HIFAR Reactor, Department of Industry, Science and Technology [1995-2000].
- * Global Advisory Group, Lloyd's Register Educational Trust Research Centre of Excellence, Pusan National University, Korea [2007-].

Professional Committee Appointments:

- Continuing Past-President, (Intl.) Civil Engineering Risk and Reliability Association [1999-]
- Executive Committee, Intl. Assn. for Structural Safety and Reliability [1985-]
- Monitoring Committee, APEC Engineer Program (DETYA/IEAust.) [1998-]

Major Awards / Recognition (since 2000):

- Corrosion Medal, Australasian Corrosion Association, 2009.
- PF Thompson Memorial Lecturer, Australasian Corrosion Association Conference, Nov. 2009.
- Visiting International Scientist, 'Biocorr' Project, European Community Marie Curie International Training Network, 2009- .
- * Keynote Plenary Lecturer, Intl. Conference on Structural Safety and Reliability, Kyoto, Japan, Sept. 2009.
- Invited Keynote Lecturer, Gordon Research Conference (Aqueous Corrosion) 2008.
- Marshall Fordham Research Paper Award, Aust. Corrosion Association, 2007, 2002, 1999.
- The Guy Bengough Award 2007, Institute Materials, Minerals and Mining, UK, for "a paper published by the Institute which makes an outstanding contribution to the subject of corrosion...".
- Visiting Research Fellowship to University of Greenwich, UK, Engrg and Phys Sci Res Council, 2006.
- TP Hoar Prize 2004 (Inst of Corrosion, UK) for best paper in Corrosion Science in 2003 (with Dr R Jeffrey)
- Visiting Research Fellowship to University of Dundee, UK, Engrg and Phys Sci Res Council, 2003.
- Safety in Construction Medal, Institution of Civil Engineers, London, 2003

Editorships:

- Foundation Editor: Australian Journal of Structural Engineering (Inst. Engineers, Australia) [1998-]
- Associate Editor, Ships and Offshore Structures (Woodhead, UK) [2005-].

Guest Editorships:

- Australian Journal of Multi-Disciplinary Engineering - Special Issue on Homeland Security [2004]
- Reliability Engineering and System Safety [2001: 74(3), 2007: 93(3)].
- Structural Safety [1996: 18(2&3)].

Editorial Boards:

- Civil and Environmental Engineering Systems (Gordon & Breach, UK) [1987-]
- Structural and Multidisciplinary Optimization (Springer, Germany) [1988-]
- Structural Safety (Elsevier, USA) [1990-]
- Reliability Engineering and System Safety (Elsevier, USA) [1998-]
- Korean Journal of Civil Engineering (Korean Society of Civil Engineers) [2006-]

- Engineering Structures (Elsevier) [2006-]
- International Journal of Engineering under Uncertainty: Hazards, Assessment, and Mitigation [2008-]
- * Structural Longevity [2009-]
- * International Journal of Lifecycle Performance Engineering [2010-].

Journal Reviewer:

Reviewer for more than 40 journals in Civil and Structural Engineering and in Corrosion and Materials Science and Engineering.

Grant Body Reviewer:

Australian Research Council – Discovery, Linkage and Laureate Grants,
 Engineering and Physical Sciences Research Council, UK,
 Natural Sciences and Engineering Research Council, Canada,
 Applied Mathematics Research Program, US Department of Energy,
 Hong Kong Research Grants Council,
 Netherlands Technology Research Foundation STW.
 Academy of Finland.

Research Statistics:

Completed PhD supervisions (primary supervisor) 17
 Current PhD supervisions (primary supervisor) 2
 Research Funding (mainly competitive from Australian Research Council) approx. \$ 13.5 million*.

Publications*:

2 Authored Books, 5 Edited Books, 5 Conference proceedings, 200+ refereed journal papers, 200+ refereed conference papers.

* For *recent* details see: <http://www.newcastle.edu.au/research/expertise/135102.html>

Recent Books:

Melchers, RE (1999) Structural Reliability Analysis and Prediction (Second Edition) John Wiley & Sons, Chichester (reprinted June 2001, July 2002, and now reprinted on demand). (First edition 1986).
 Stewart MG, Melchers RE (1997) Probabilistic Risk Assessment for Engineering Systems, Chapman & Hall, London & Tuttle-Mori Agency Inc, Tokyo, 251 pages (2003 Japanese translation).
 Melchers RE and Hough, R, (2007) (Eds) Computational Analysis of Complex Structures, ASCE Press.
 Paik JK and Melchers RE (2008) (Eds) Condition Assessment of Aged Structures, Woodhead Publishing Ltd, Cambridge.

Engineering Consulting (2000-):

2010-11	Advice and investigations of corrosion of cast iron railway bridge columns, SKM, Sydney.
2010	Expert advice on corrosion and risk of collapse of Lane Cove Swimming Centre - Legal.
2010	Expert advice on sewage, structural and risk aspects of Regatta Wharf development - Legal.
2009	Review of Gibson Street multistory carpark - Newcastle City Council.
2008	Remedial actions and risk analysis for Boyne Island Crane runway structure – SKM.
2008	Overview of risk assessment for offshore risers - AMOG Consulting, Melbourne
2007	Liquefied Petroleum Gas mobile system risk assessment.
2007	Expert Witness and advice for legal case involving Pymont development project.
2006	Reliability assessment methodology and application review - Alcan Engineering, Brisbane.
2006	Advice on cable ladder corrosion and support - Origin Energy
2005	Advice on stress aspects of design of pipeline system - JWP
2005	Advice on deterioration issues at Noah's Hotel - Noah's
2002-3	Structural integrity of Collins Class submarines - Department of Defence.
2002	Sensitivity and reliability analysis for corrosion damage computer program - CSIRO/DSTO.
2002	Review of risk assessment for high-voltage cable between Victoria & Tasmania - HydroTas.
2001	Advice on corrosion and deterioration of large water tank at chemical plant - Pasminco.
2000	Advice on seismic risk criteria for replacement reactor project - ARPANSA.
2000	Investigation of car-park floor slab and assessment of structural risk – Kingston Apartments.
2000	Investigation of hydrogen sulfide leakage and associated risk assessment – MV Seahorse Mercator, Defence Maritime Services Pty Ltd.
2000	Review of corrosion and deterioration condition and associated risk analysis for a 450 m prestressed concrete road bridge, Tasmania.
2000	Risk assessment for LPG system, Origin Energy.
2000	Computer program development for fatigue reliability analysis for mining equipment, SKM Consultants, Sydney.

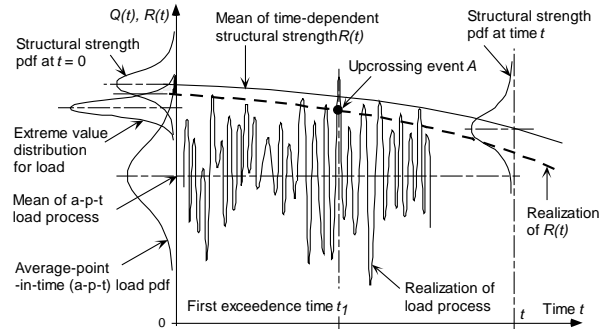
RESEARCH INTERESTS

Structural reliability assessment for major infrastructure, ships and offshore structures

Structural reliability evaluation involves estimating the probability of structural or system failure in one or more defined failure modes. In this process the uncertainties inherent in loads, load processes, resistance and other parameters need to be considered. This is in contrast to the conventional design approach that uses nominal or 'design' values. For loading processes considered as stochastic processes in time, up- and out-crossing analyses are employed. The techniques have found application in a variety of applications.

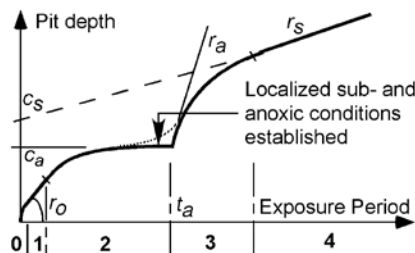
Efficient computational methods for structural reliability

Because of the complexity of many realistic structures and systems, estimation of their reliability is seldom feasible with analytic or analogue methods. Recourse often must be made to simulation techniques. The methods being explored include Directional Simulation in the Load Process Space. This allows the loads to be expressed directly as stochastic processes. The structural system becomes, in the general case, a time variant (but not stochastic) system.

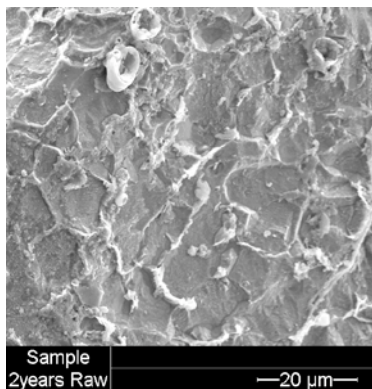


Corrosion and Deterioration Modelling

The deterioration of structural materials under adverse conditions, such as the corrosion of steel in seawater environments constitutes a major cost to industry. It is desirable to predict how much corrosion is likely to occur under given (uncertain) conditions in a future period of time. New models are being developed for immersion, tidal and atmospheric corrosion of steels, considering also bacterial, environmental and man-made influences. The approach is based on the use of probabilistic models for the corrosion rate processes. This is consistent with the needs of industry and with structural reliability theory. Both general corrosion and pitting corrosion are considered. Most effort has been devoted to structural steels but this is being extended to reinforced concrete. The research is backed by an extensive field program with exposure sites at several places along the East coast of Australia and use of SEM, EDS, XRD and bacterial culturing analyses.



- Phases**
- 0 - Surface colonized by bacteria etc.
 - 1 - Rate of metal oxidation controlled by rate of diffusion of oxygen from seawater
 - 2 - Metal oxidation rate progressively reduced by build-up of corrosion products
 - 3 - Sub- and anoxic conditions allow bacteria to flourish under ample nutrient supply
 - 4 - Metabolism of IOB and SRB and loss of rust through erosion and wear



SEM image of steel surface corroded in seawater for 2 years.



Metal surface after rust removal showing a variety of marine rusts. Some are not adherent (i.e. bright steel revealed) - thought to be the result of bacterial activity.



Field testing at Belmont Beach



Metal surface after cleaning off rusts showing wide variation in pitted surface topography.



Anaerobic marine corrosion of reinforcing bar recovered from 65-year-old concrete structure.

• **Reinforcement corrosion**

Corrosion of reinforcement in concrete structures is a major international problem particularly for structures exposed to chloride environments, such as those along sea and ocean coastlines. The conventional wisdom is that the rate of diffusion of chlorides through the concrete cover from the external environment governs the life expectancy of reinforced concrete structures. Much of this has been obtained from laboratory studies under controlled conditions, including the use of electrochemical means to artificially accelerate the rate of reinforcement corrosion. However, our recent observations of the long-term behaviour of actual reinforced (and prestressed) concrete structures in realistic exposure conditions have shown that structures can survive for many decades, with little or no reinforcement damage even if chloride contents are high and/or concrete cover is low or of poor quality. However, in other cases very severe corrosion losses have been found even without the build-up of corrosion products and with little or no external evidence that corrosion is occurring within the concrete structure. Because of the very serious practical implications of these observations, they are receiving intense research attention.



Typical longitudinal concrete cracking and staining due to reinforcement corrosion.



Severe corrosion of prestressing strand without evidence of the usual build-up of corrosion product.



Severe localized corrosion and complete loss of reinforcement, without visible external damage.



Recent view of a Phoenix Mulberry Harbour caisson dating from 1943, showing only limited concrete spalling and external evidence of reinforcement corrosion even after more than 60 years direct marine environment exposure.

One of four 1923 reinforced concrete silos at Maria Island, Tasmania. It shows only limited concrete spalling despite more than 80 years exposure in a marine environment.