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The following editorial policy has been adopted by the Board of the College of Mechanical Engineers. The College shall:

1. Publish mechanical engineering papers, especially those of Australian origin or interest.
2. Receive for consideration by reviewers any paper presented at a conference organised by any section or group of Engineers Australia.
3. Develop volumes devoted to one subject area that will be saleable as an individual volume.
4. Aim to be a forum for mechanical engineering science and practice.
5. Invite state-of-the-art papers.
6. Distinguish papers by the following areas:
 - Science and research;
 - New knowledge;
 - Research results;
 - Practice and design, including review;
 - Technical notes, design notes and letters;
 - Discussion of published papers; and
 - Publish important addresses and communications.

Suggested subject areas for devoted volumes shall generally relate to the national committee groupings with sub-categories such as:

acoustics and noise
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aerothermodynamics
component manufacturing
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conveyors
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stress analysis
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Cover photo

In this special issue of the *Australian Journal of Mechanical Engineering*, Widders et al outline the general process of troubleshooting and rectifying unexpected structural mechanics problems in industrial plant and infrastructure, such as fan ducting (main) and centrifugal fans (inset); see pp. 143-152.

Fifth Australasian Congress on Applied Mechanics

This issue of the *Australian Journal of Mechanical Engineering* (AJME) contains selected papers from the Fifth Australasian Congress on Applied Mechanics (ACAM 2007), held in Brisbane in December 2007.

This conference series is run by the National Committee on Applied Mechanics (NCAM) of Engineers Australia, with the first in the series held in Melbourne in 1996. The series aims to provide an international forum for researchers, industry practitioners and postgraduate students to promote, exchange and disseminate their knowledge and experiences of the most recent results and conceptual advances in a wide range of topics in Applied Mechanics.

The papers were selected by the members of NCAM and are representative of the range of topics covered at the conference in the areas of biomechanics, constitutive modelling, composite materials, fatigue and fracture, impact dynamics, and nano- and micro-mechanics. These papers are indicative of the high quality of the work being undertaken in these areas in Australia. All the papers have been reviewed for publication in AJME by experts in the relevant technical area.

It is the goal of the editorial staff at AJME to publish papers representative of the full range of activities in Mechanical Engineering and related disciplines. The future success and quality of the journal is entirely dependent on the contributors and I strongly encourage submissions from both the research and industrial sectors of the profession.



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All correspondence, including manuscripts and advertising enquiries, should be addressed to Engineers Media, PO Box 588, Crows Nest NSW 1585. Abstracting is permitted with due credit to the Australian Journal of Mechanical Engineering. Reprints of technical articles are available. Quantities of not less than 25 may be ordered.

Design, modelling and measurement of a hybrid powerplant for unmanned aerial systems

KEYWORDS: Aircraft; hybrid; propulsion; performance; simulation.

ABSTRACT: Hybrid powerplants combining internal combustion engines and electric motor prime movers have been extensively developed for land- and marine-based transport systems. The use of such powerplants in airborne applications has been historically impractical due to energy and power density constraints. Improvements in battery and electric motor technology make aircraft hybrid powerplants feasible. This paper presents a technique for determining the feasibility and mechanical effectiveness of powerplant hybridisation. In this work, a prototype aircraft hybrid powerplant was designed, constructed and tested. It is shown that an additional 35% power can be supplied from the hybrid system with an overall weight penalty of 5%, for a given unmanned aerial system. A flight dynamic model was developed using the AeroSim Blockset in MATLAB Simulink. The results have shown that climb rates can be improved by 56% and endurance increased by 13% when using the hybrid powerplant concept.

REFERENCE: Glassock, R., Hung, J. Y., Gonzalez, L. F. & Walker, R. A. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 69-78.

Infant brain subjected to oscillatory loading

KEYWORDS: Shaken baby syndrome; brain injury; cerebrospinal fluid; finite element.

ABSTRACT: Past research into brain injury biomechanics has focused on short duration impulsive events as opposed to the oscillatory loadings associated with Shaken Baby Syndrome (SBS). A series of 2D finite element models of an axial slice of the infant head were created to provide qualitative information on the behaviour of the brain during shaking. The test series explored variations in subarachnoid cerebrospinal fluid (CSF) thickness and geometry. A new method of CSF modelling based on Reynolds lubrication theory was included to provide a more realistic brain-CSF interaction. The results indicate that the volume of subarachnoid CSF, and inclusion of thickness variations due to gyri, are important to the resultant behaviour. Stress concentrations in the deep brain are reduced by fluid redistribution and gyral contact. These results provide direction for future 3D modelling of SBS.

REFERENCE: Couper, Z. S. & Albermani, F. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 79-86.

Investigation of plasticity-induced fatigue crack closure

KEYWORDS: Crack closure; crack opening stress; crack tip plasticity; distributed dislocation technique; edge dislocation; plate thickness effect; through-the-thickness crack.

ABSTRACT: Plasticity-induced crack closure and constraint effects due to finite plate thickness are both fundamental aspects in the mechanics of fatigue cracks. Moreover, plasticity-induced crack closure provides an effective first-order correction to the crack driving force, as used in the correlation and prediction of fatigue crack growth. The approach developed in this study utilises the distributed dislocation technique to model fatigue cracks growing under constant amplitude loading in finite thickness plates. Numerical results are obtained through the application of Gauss-Chebyshev quadrature and are presented for the crack opening stress ratio. An excellent agreement is observed with previous three-dimensional finite element studies.

REFERENCE: Codrington, J. & Kotousov, A. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 87-94.

ABSTRACTS

Crease formation in the processing of thin web material

KEYWORDS: Buckling; creasing; elastica; thin strip; wide strip; web mechanics; snaking; strip tracking.

ABSTRACT: A mathematical model is developed to describe the conditions for buckling of steel strip between transport rolls due to strip camber, together with conditions necessary for the subsequent “ironing-in” of the buckle as it passes over the downstream roll. For a permanent crease to form, the buckle must be sufficiently stable so that it is prohibited by friction to spread laterally, and the stresses from the buckle defect must be large enough for plastic deformation to occur as it travels over the downstream roll. Once the conditions to produce a permanent crease are known they can be avoided in plant operations.

REFERENCE: Dixon, A. & Yuen, W. Y. D. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 95-100.

New passive defect detection technique

KEYWORDS: Crack detection; continuum mechanics; distributed dislocation technique; edge crack; finite difference; non-destructive evaluation technique; strain compatibility; structural health monitoring.

ABSTRACT: This paper discusses the development of a new passive technique of online damage detection based on the most fundamental concept in continuum mechanics – strain compatibility. The main feature of this method is its invariance to changing loading conditions. The technique is quite general, and can be applied to structures made of isotropic or anisotropic materials and structural components experiencing elastic or plastic deformations. The detection of an edge crack utilising this technique is considered in this paper and demonstrates a good potential of this method for many practical applications.

REFERENCE: Wildy, S., Kotousov, A. & Codrington, J. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 101-106.

Locating leaks in underground water pipes using the complex cepstrum

KEYWORDS: Leaks; underground water pipes; cepstrum; cross correlation.

ABSTRACT: It is possible to detect the presence of leaks in underground water pipes by measuring, at remote locations such as hydrants, the noise or vibration caused by the leak. The time delay of the leak noise reaching the different sensors can be computed using the cross correlation, and with knowledge of the wave-speed in the pipe, the location of the leak may be pinpointed. This paper presents a new technique for leak detection that employs the cepstrum, rather than the cross correlation, for estimation of the delay time. The delay time manifests as a series of peaks in the cepstrum, rather than a single peak in the correlation, allowing a more robust estimate. A number of cepstrum formulations are presented that are derived from correlation estimators, and it is found that the time delay information is actually contained in the phase component of the cross spectrum. Based on this, a phase cepstrum estimator is developed.

REFERENCE: Hanson, D., Randall, R. B., Brown, G. & Emslie, R. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 107-112.

Interference fit fastener inspection using sonic thermography

KEYWORDS: Infrared; interference fit; non-destructive evaluation; sonic IR; sonic thermography.

ABSTRACT: This paper reports on an experimental study addressing the application of sonic thermography to the characterisation of interference fit levels in fastened metallic plates. The technique uses high intensity acoustic waves to induce frictional heating at defect locations. In the case of poorly fitted interference fasteners, the acoustic waves induce relative motion between the fastener and host, causing frictional heating that is detected with a thermal imaging system. Results are shown to demonstrate the efficacy of the approach.

REFERENCE: Tsoi, K. A. & Rajic, N. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 113-118.

Automation of optimal laminate design

KEYWORDS: Blending; composite; design; engineering automation; genetic algorithm; heuristics; manufacturing constraints; optimisation; laminate.

ABSTRACT: Composite laminates are in widespread use in the aerospace industry. As well as satisfying strength and stiffness criteria, the final laminate design has to be manufacturable in terms of compatibility between adjacent panels, thus introducing conflicting constraints on the allowed laminate stacking sequences. An attempt to automate the laminate design process is described in this paper. The method uses a mixture of a genetic algorithm and heuristics to satisfy the various design and manufacturing constraints. Multiple zones are allowed, where each zone defines a panel together with a set of applied loads. Guide laminates and a blending methodology allow each zone to share common plies. This creates ply continuity across the structure, and avoids the scenario seen in other laminate optimisation tools where each optimised zone contains unrelated laminates that are not practical from a manufacturing perspective.

REFERENCE: Coates, T., Smith, A., Emanuel, M. & Peterson, B. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 119-126.

Failure of sandwich composite structure containing face-sheet/core disbonds – an experimental study

KEYWORDS: Buckling; damage tolerance; disbond; failure; growth; sandwich; testing.

ABSTRACT: During this study, a number of honeycomb sandwich specimens containing circular manufactured disbonds were loaded to failure in bending. Particular emphasis was placed on accurately identifying the occurrence of disbond buckling and growth initiation, as these two events are inherently difficult to monitor. This study aims to fill a large gap in the published literature regarding experimental results for disbanded sandwich structures. The test results are presented in three sections; firstly, the buckling, growth initiation and failure loads are presented for each of the six tested configurations; secondly, the method of identifying disbond buckling is explained; and thirdly, the method of identifying disbond growth initiation is presented. Finally, conclusions are drawn and there is discussion of the results in terms of damage tolerance and design considerations.

REFERENCE: Southward, T., Horrigan, D. P. W., Mallinson, G. D. & Jayaraman, K. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 127-134.

Numerical simulation of a collapsible non-linear structure subjected to impacts

KEYWORDS: Collapsible multilayer structure; impacts; non-linear dynamics; numerical simulation; cushioning; multi-degree of freedom system.

ABSTRACT: A numerical model for the simulation of dynamic compression of a collapsible multilayer structure subjected to transient compressive excitation is described and tested in this study. It is shown that impacts induce a chaotic collapse of crumple layers. The simulations predict shock pulses and intralaminar forces. Simulated shock pulses that a free-falling impactor is subjected to, and the corresponding animated deformation histories of the layers, are compared with the high-speed videography. Cushioning performance maps and shock response spectra maps obtained from the simulations are presented. The use of collapsible structures for cushioning applications is discussed.

REFERENCE: Sek, M. A. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 135-142.

ABSTRACTS

Troubleshooting and rectifying structural mechanics problems – applied mechanics in industry

KEYWORDS: Troubleshooting; rectifying; structural mechanics; site measurements; computational simulations; correlations; root cause sources; redesign.

ABSTRACT: This paper outlines the general process of troubleshooting and rectifying unexpected structural mechanics problems in industrial plant and infrastructure. Typically the process includes the combination and correlation of site measurements (strain, vibration) and computational simulations (finite element analysis, computational fluid dynamics) to identify root cause sources and guide redesign and rectification means. Details of typical site installations are outlined, including mining machinery, gas pipelines, railway lines, manufacturing plant and ships. Four case studies are included, ranging from resin manufacturing tubular agitators suffering vortex induced resonance, ore grinding mills needing better access manhole design, mine dump trucks, and ship shafting issues.

REFERENCE: Widders, R., Morris, B. & Mason, S. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 143-152.

Optimum shapes for minimising bond stress in scarf repairs

KEYWORDS: Composite materials; optimum shapes; scarf repairs.

ABSTRACT: Bonded scarf repairs are used in composite structures when high strength recovery is needed or when there is a requirement for a flush surface to satisfy aerodynamic or stealth requirements. However, scarf repairs are complex to design and require the removal of significant parent structure, particularly for thick skins. In this investigation, analytical and numerical approaches have been developed to investigate whether an optimum repair shape for a known biaxial load can be determined. The results clearly demonstrate that the strength of a repaired panel can be improved by optimising both the initial damage cut-out shape and the scarf angle distribution.

REFERENCE: Wang, C. H. & Gunnion, A. J. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 153-158.

Optimising slew torque on a mining dragline via a four degree of freedom dynamic model

KEYWORDS: Dragline; dynamic model; fatigue; optimisation; productivity; mining; non-linear; stress.

ABSTRACT: In this study, a dynamic model of a dragline is developed in the form of a fundamental non-linear rotating multi-body system with energy dissipation. Its dynamic behaviour is investigated using measured field data. Model predictions of dynamic behaviour and stresses during operation are investigated and a comparison with measured data presented. Preliminary results from an investigation into reducing fatigue duty via improved slew torque control are also presented. The dynamics of the dragline bucket swing motion during house slewing (rotation) are of particular importance for both structural loading and efficient operation.

REFERENCE: McInnes, C. H. & Meehan, P. A. 2008, *Australian Journal of Mechanical Engineering*, Vol. 6, No. 2, pp. 159-164.

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 - Headings and subheadings should be numbered, eg. 1 Heading, 1.1 Subheading, 1.1.1 Sub-subheading, etc.
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 - Tables should be numbered consecutively in separate series, eg. Table 1: caption, Table 2: caption, etc. Tables can be placed within the text near where they are first referred to or listed at the end of the paper.
 - Appendices should be lettered, eg. Appendix A, Appendix B, etc.
 - Equations should be numbered consecutively as they appear in the text and be referred to by their number, eg. equation (1), equation (2), etc.
4. Only English (UK) spelling is acceptable.
5. Only SI units are acceptable in text, tables and figures.
6. References should be in the Harvard (author, date) format within the body of the text (eg. Smith, 2000; Smith & Jones, 2005; Smith et al, 2002) and listed by lead author alphabetical order at the end of the paper.

Each technical paper received for publication in the Engineers Australia Technical Journals is reviewed for the journal's editorial panel by at least two independent peer reviewers. The editorial panel considers the reviews and decides whether or not a paper is to be accepted, revised and resubmitted, or rejected. The names of members of the various editorial panels are listed in the journal issues. If accepted, a copy of the manuscript will be returned to the author together with appropriate comments by reviewers and editors, and instructions for the preparation of the final copy.

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1. Discussion of a paper/technical note is open to anyone who has significant comments or questions regarding its content. Discussion papers will be accepted for a period of four months following the publication of the relevant journal issue. All discussions are to be in the third person, with the discussor being referred to as "the writer" and the author of the original paper as "the author".
2. Technical Notes provide the opportunity for the dissemination of technical ideas that are not sufficiently developed to warrant a full paper. Such notes should not exceed 1500 words with two diagrams.
3. Papers presented at a recent conference relating to the journal's subject area may be submitted for publishing consideration as a Conference Paper. The author must inform the journal office which conference the paper was presented at and whether the paper has been published in the conference proceedings. Authors who wish to have their conference paper considered for publishing as a full Technical Paper will need to significantly update and expand on the original paper.
4. Project Reports provide the author with the opportunity to inform the journal's readers about a recent project they were involved in that relates to the journal's subject area. These reports may not necessarily be peer-reviewed and can be accepted for publication at the editorial panel's discretion.
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