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Book Reviews

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Damage Tolerance and Durability of Material Systems

Kenneth L. Reifsnider and Scott W. Case, Wiley, New York, 2002, 435 pp., $99.95

As stated by the authors, the premise of this book is based on two major elements, the first of which is the assemblage and interpretation of data as accumulated over the time period of a generation on the subject areas of durability, damage tolerance, and fatigue. To this end, the authors have done a service to the composites community in bringing forward this information to active researchers in the field as well as to graduate students contemplating research in these areas. The second element is related to the introduction of a new philosophy related to the concept of defining damage based on the remaining strength of the material as the tenet for a damage precept. Because composites require the conceptual introduction of new ideas, the authors' discussion of a so-called new philosophy should be refreshing to the reader of this book.

However, in bringing forward this discussion, it would be advantageous to the reader for the authors to review some of the legacy descriptions of durability, damage tolerance, and fatigue as they relate to damage. The literature is replete with definitions related to the aforementioned subjects, which to some extent may represent the interest of the individual researcher. It would thus be beneficial if these notions/ideas/concepts could have been collectively reflected upon in this text. For example, the basic philosophy of damage-tolerant design encompasses the tenets that damage will occur, that an adequate system of inspection for damage detection be established, and that adequate strength be maintained in the damaged material. Although a number of these tenets are discussed in the book, some are only touched on. It would also have been instructive to the reader to tie the concepts introduced to the overarching subject of structural integrity that these elements support.

The book itself is composed of eight chapters, including an introduction with basic concepts discussed, a chapter focused on the physical behavior of continuous fiber composites, and chapters on strength and stiffness evolution. Chapter eight, which discusses example applications and case studies of the material, should be especially welcomed by the reader. In terms of continuity, this reviewer would recommend that the reader reverse the order of Chapters 4, 5, and 6. Overall this book can be a useful reference to researchers and graduate students dealing with structural integrity issues. As an aside, this reviewer's copy of the book had incomplete printing on pages 361–376.

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Direct and Large-Eddy Simulation IV

Edited by B. Geurts, R. Friedrich, and O. Métais, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2001, 526 pp., $174.00

Direct and Large-Eddy Simulation IV is the proceedings of a workshop of the same title held at the University of Twente in July 2001, one in a series of workshops organized by the European Research Community on Flow, Turbulence and Combustion (ERCOFTAC). The proceedings contains 60 papers. The contributors represent the leading researchers in the field of direct numerical simulation (DNS) and large eddy simulation (LES) of turbulence. A strong international participation was achieved. Represented countries are Belgium, Canada, France, Germany, Italy, Japan, The Netherlands, Norway, Switzerland, the United Kingdom, and the United States.

The papers ranged in content from "works in progress" (indicating potential for significant results but short of an archival contribution) to new results of substantial importance. The papers cover a broad range of categories in DNS and LES, including physics of turbulence and combustion, algorithms and techniques, models, and applications. Of particular interest is the wide range of applications of DNS and LES and the remarkable agreement achieved between these simulations and experiment. In the following, a sample of the application papers is described.

Avital ("Direct and Large Eddy Simulations of Compressible Open Cavity Flows") presents a study of DNS and LES for Mach 0.6 flow past an open cavity for a length L to depth D ratio $L/D = 6$. DNS was performed for Reynolds number $Re = 10^3$ (based on depth) and LES for $Re = 3 \times 10^3$ and 10^4 at incoming momentum thickness $\theta/D = 20.6$ and 41.1. The computed dominant modes showed good agreement with the empirical formula of Rossiter.

Raverdy et al. ("Large Eddy Simulation of the Flow Around a Low Pressure Turbine Blade") present an LES of flow past a T106 turbine blade at Mach 0.1 and $Re = 1.6 \times 10^5$ (based on chord). The MILES (monotone integrated LES) technique is used, wherein the energy transfer from resolved to subgrid scales is assumed to be performed by the inviscid flux algorithm [in this case, the AUSM + (P) technique]. Results for mean surface pressure and mean and rms streamwise velocity show good agreement with experiment.

Neumann and Wengle ("Active Control of Turbulent Separated Flows Using LES") describe an LES of an adaptive feedback control of the separation length for a backward-facing step of height h at Reynolds number $Re = 3.3 \times 10^4$ (based on height) and a surface-mounted fence at $Re = 3 \times 10^3$. The constant coefficient Smagorinsky model is used for the subgrid scale (SGS) stresses. Harmonic surface blowing/suction is used as the forcing technique. The computed frequency for maximum reduction in the separation length and the corresponding mean separation length at maximum reduction show good agreement with experiment.

Mary and Sagaut ("Large Eddy Simulation of Flow Around a High Lift Airfoil") present an LES of flow past an airfoil at Mach 0.15, Reynolds number $Re = 2.1 \times 10^6$ (based on the chord c), and angle of attack 13.3 deg using the selective mixed scale model (SMSM). The flowfield exhibits complex features including laminar separation and turbulent reattachment near the leading edge and turbulent separation near the trailing edge. Very good agreement is achieved with experimental mean surface skin friction, pressure, and streamwise velocity. Comparison of computed and experimental rms streamwise, wall normal, and resolved shear stress show good agreement.

Leonardi and Orlandi ("DNS of Turbulent Flows in a Channel with Roughness") describe a series of six DNS for turbulent flow past sinusoidal and square wave surface roughness. The mean velocity profiles above the roughness are in good agreement with the experimental law of the wall.

Moulinec et al. ("Diagonal Cartesian Method on Staggered Grids for a DNS in a Tube Bundle") performed a DNS for flow past an array of cylinders at $Re = 6 \times 10^3$ using a modified Cartesian grid algorithm. Results show good agreement with experiment.

Menon ("The Use and Relevance of Reacting LES in an Engineering Design Cycle") presents applications of a reacting LES methodology to combustion diagnostics in a microengine and swirl combustion in a lean premixed gas combustor. A novel approach to finite rate kinetics using an artificial neural network is described.

Milelli et al. ("Large Eddy Simulation of Turbulent Shear Flows with Bubbles") describe an LES for an incompressible mixing layer with a low void fraction of bubbles. Both constant coefficient and dynamic Smagorinsky models are used. Results show generally good agreement with experiment.

Overall, *Direct and Large-Eddy Simulation IV* is an excellent overview of the state of the art in DNS and LES. I highly recommended it for researchers in this field.

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