Rezensionen

Mang, H.; Hofstetter, G.:
Festigkeitslehre
Springer-Verlag, Wien, New York (2000)
486 Seiten, 232 Abb.
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Das Buch ist als Lehrbuch geschrieben und für Studierende und Absolventen der Ingenieur-Wissenschaften gedacht, wie auch als Nachschlagwerk für in der Praxis tätige Ingenieure. Der inhaltliche Aufbau ist deduktiv angelegt. Begonnen wird mit einer kurzen mathematischen Propädeutik, wobei die Tensorrechnung im Vordergrund steht. Danach werden die dreidimensionale Deformations- und Spannungsanalyse ausführlich entwickelt. Als wichtigstes Materialgesetz wird das Hookesche Gesetz in seinen anisotropen und isotropen Versionen hergeleitet. Zum allgemeinen Teil gehören dann noch die Bilanzen, sowie die Variations- und Energieprinzipien.
Danach wird das Buch speziell und handelt im Wesentlichen nur noch von Stäben unter Dehnung, Biegung, Torsion und Schub. Flächentragwerke werden dagegen nicht vertieft. Dafür werden an Stäben auch Probleme der Stabilität, des Versagens ("Anstrengungshypothesen") bezüglich Bruch, Fließen usw. und nicht-lineares und inelastisches Verhalten (hauptsächlich plastisches) abgehandelt. Gegen Ende wird noch auf Näherungsverfahren zur Lösung der Randwertprobleme und auf experimentelle Verfahren eingegangen.
Diese Stoffauswahl erscheint dem Rezensenten nachvollziehbar. Man mag einwenden, dass auch Scheiben und Schalen in ein solches Buch gehören. In Anbetracht seines ohnehin schon recht großen Umfanges von fast 500 Seiten hat man aber hier eine Auswahl treffen müssen.
Bezüglich der Darstellung seien aber einige kritische Bemerkungen angebracht. Die Autoren bedienen sich im Wesentlichen einer indizistischen Tensornotation, die bekanntlich wenig übersichtlich ist und deshalb heutzutage in derartigen Lehrbüchern auch immer weniger favorisiert wird. Die Einführung des Tensor- oder Dyadenbegriffs, wie er auf S. 9 gegeben wird, dürfte allerdings einem Studenten, der die Tensorrechnung noch nicht beherrscht, völlig unklar bleiben.
Auch die Ableitungen in der Kontinuumsmechanik sind didaktisch nicht immer gelungen. Die Autoren beweisen zwar, dass sie virtuos mit infinitesimalen Elementen umgehen können; wir wissen aber auch, dass gerade diese den Einsteiger in dieser Materie vor erhebliche Verständnisprobleme stellen. Hinzu kommen mancherlei begriffliche Unklarheiten. So wird eine Einteilung in innere und äußere Kräfte benutzt, die aber nirgends verständlich gemacht wird. Offenbar ist aber nicht die Unterscheidung in Massen- und Oberflächenkräften gemeint. Als "dynamisches Grundgesetz" wird $d\mathbf{R} = dm\ \mathbf{b}$ eingeführt, wofür zur Verwunderung des Rezensenten Parkus (1960) zitiert wird. Auf der nächsten Seite wird dann die "Herleitung" dieser Gleichungen angekündigt. Wie nun? Ist das Gesetz ein Axiom oder eine Folgerung von anderen Axiomen? Und wenn ja, aus welchen? Auch der Drallsatz wird nicht als unabhängiges zweites Axiom klar benannt, sondern taucht als Momentengleichgewicht am infinitesimalen Element auf. Gilt also das Boltzmannsche Axiom nur im Gleichgewicht? Auch die Ableitungen der Prinzipien entbehren einer gedanklichen Klarheit, die man sich für Lehrbücher wünschen würde.
Lohnend ist das Buch nicht wegen seiner Ableitungen, sondern wegen seiner zahlreichen durchgerechneten Beispiele, insbesondere in der relativ ausführlichen Stabtheorie. Hierfür kann es weiterempfohlen werden. Die angeführte Literatur ist recht dürftig, was aber bei einem so klassischen Stoff verzeihlich ist. Inzwischen ist eine 2., aktualisierte Fassung erschienen.

A. Bertram

Erwen, J.; Erwen, M.; Hörwick, J.:
Vorkurs Mathematik
Oldenbourg Verlag München Wien, 2003
252 Seiten, 19,80 €
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In the recent years it was stated by many institutions and surveys, for example by MathSoft Education and Engineering or PISA, that the mathematical skills of students are often poor. So they are not able to pass examinations and drop out of engineering university courses at high rates. Therefore we need to look for better ways to prepare today’s and future’s students for their studies. To reach this aim, many universities held courses to refresh the mathematical knowledge of new students. For this purpose also many books have been written.

This “Vorkurs Mathematik” is written for students of technical and economical subjects and is based on a course held by the authors at a college in Munich since several years. It covers all subjects, which should be known at the beginning of studies. The fundamentals of arithmetic, equations and inequalities, geometry, functions, vector calculus, integral and differential calculus are repeated and explained. To improve the readers skills there are given examples and exercises with solutions. Important rules and statements are highlighted.

However, there are some chapters which should be extended. For example the handling of systems of simultaneous equations, chapter 3, presents the

“Additionsverfahren” and “Gleichsetzungsverfahren”, only. The “Cramer’s rule” (in this case one needs determinants) or how to solve these systems by means of matrices are not mentioned. Unfortunately matrices and determinants are not taken into account in this book.

In chapter 6 on vector calculus, it is not easy to recognize whether a variable is a vector or not. In typography there should be a clear difference between a scalar and a vector, for instance by means of underlining or boldface. In this chapter one also finds the dot product, but the cross product is missing.

In chapter 9, integral calculus is explained. There should be a clear distinction between a scalar factor c (function c*x) and the integration constant c. The physical or technical meaning of integration constants should be pointed out for the further understanding of applications, as well as the determination of such a constant.

In summary, this book can help to recall or to improve mathematical skills at the beginning of studies. It is a suitable book in pre-courses and for self-study.

W. Lenz

Eringen, C.:
Nonlocal continuum field theories
Springer, 2002, 376 p., 72 illus.
ISBN 0-387-95275-6 , 223,63 €

Cemal Eringen, pioneer of the mechanics of generalized continua in the early sixties and founder and Editor–in–Chief of the well–known International *Journal of Engineering Science*, gratifies us with three new books at the rise of the XXIst century :

• *Microcontinuum field theories, Vol. I: Foundations and Solids*
• *Microcontinuum field theories, Vol. II: Fluent Media*
• *Nonlocal continuum field theories*

all published by Springer. Every mechanician or physicist interested in continuum theories of media with microstructure has carefully studied Eringen’s milestone book series *Continuum Physics* which goes back to 1976. In the volume called *Polar and nonlocal field theories*, Eringen together with his colleagues D.G.B. Edelen and C.B. Kafadar laid the foundations of the continuum theory of polar, micromorphic and non local media. He wrote the kinematics, balance and constitutive equations for such generalized media in an accurate and exhaustive way that remains the reference today. The three new books contain the material from *Continuum Physics* but also bring some new elements obtained by the author, and, to a lesser extent, from the literature in the last twenty years.
The volume *Nonlocal continuum field theories* concentrates on the formulation of nonlocal balance and constitutive equations in the context of mechanics, but also of electromagnetic theory. The motivations for abandoning the principle of local action becomes evident in several physical and mechanical problems : fracture of solids, stress fields at the dislocation core and at the crack tip, singularities present at the point of application of concentrated loads (forces, couples...) and the dispersion of short wavelength elastic waves. Within the framework proposed by Eringen, the representation of internal forces still goes through the introduction of a surface load vector which depends linearly on the unit normal vector and thus involves a second order symmetric stress tensor. It is shown then that a local form can be given to the equations of conservation of mass, balance of momentum, moment of momentum and energy, provided that so–called nonlocal residuals are taken into account. However, the balance laws will remain in their local forms to a very high degree of accuracy. The nonlocality is then confined to the formulation of constitutive equations for stress and energy.
Astonishingly, the second gradient theory as discovered by Mindlin [1] and presented in [2] within the context of the principle of virtual power, is described in detail in none of Eringen’s recent books although it represents a step toward nonlocality and the introduction of microstructural features in the continuum modelling of materials. The representation of internal forces in a second grade medium involves a second order stress and a third order hyperstress tensor, which in turn leads to surface loads which depend not only on the unit normal vector but also on local surface curvature. This suggests that a fully nonlocal theory should incorporate a more refined description of internal forces and surface loads than a single symmetric stress tensor. Accordingly, the nonlocal continuum model proposed by Eringen is perhaps a simplified framework, which turns out to be efficient enough to bring first answers
to the physical problems mentioned earlier. This does not exclude the construction of more general nonlocal field theories in the future.
Nonlocal constitutive equations must fulfill the usual invariance principles of mechanics but it is physically reasonable to assume that particles too far from reference point $\underline{\boldsymbol{X}}$ do not appreciably affect the values of the constitutive variables at $\underline{\boldsymbol{X}}$. The neighborhood of influence reduces to a small cohesive zone. In the case of memory–dependent nonlocal thermoelastic solids, and following the exploitation of the second principle of thermodynamics, the state laws keep their classical form up to non

constitutive residuals. In the case of fluids, there is the interesting result that pressure and static entropy do not possess nonlocality.

The most significant results of the book are obtained within the context of linear thermoelasticity for which the stress tensor, the heat flux vector and the entropy are functionals of the strain and temperature field, i.e. integrals over the entire body or at least over a finite neighborhood. Kernel functions for these integrals are proposed and can be identified for instance from lattice dynamics, by matching a dispersion curve with atomic models. In general, all such kernels appear to lead qualitatively to the same result, namely, *"the elimination of singularities of the local theory and attenuation with distance"* :

• The stress field, and the stored energy, at and around a screw or edge dislocation are non singular but depend on an internal characteristic length.
• There is no stress–strain singularity at a crack tip any longer. The maximum stress is located ahead from the crack tip. A fracture criterion can therefore be based on maximum stress considerations.

Eringen claims then that *"these overwhelming results should convince the fracture mechanics community that there is no need for all those ersatz regarding fracture criteria (e.g., energy, fracture toughness, J–integral, etc.)".* This stimulating statement should encourage us to try!

The last chapters of the book deal with nonlocal microcontinua, i.e. the combination of nonlocal constitutive equations and continuum models enhanced by additional degrees of freedom : micropolar and micromorphic nonlocal continuum theories, and their application to the propagation of waves. Lastly, the formulation of constitutive equations of memory–dependent nonlocal micropolar electromagnetic elastic solids does not lack a certain formal beauty.

One may regret that the book is mainly restricted to elastic solids and viscous fluids and does not envisage the case of plasticity nor damage of materials. Many contributions within the last twenty years have been provided showing that the treatment of plasticity and damage also requires nonlocal theories and constitutive functionals [3]. It turns out that in such cases the nonlocal zone of influence can be considerably larger that in the case of elasticity (μm up to mm, instead of a few atomic distances), so that the most promising applications of nonlocal theory will perhaps be found within the context of plasticity of damage rather than in elasticity. The exclusion of such nonlinear models may explain why more than 80% of the references quoted in the book are due to the author and collaborators. We really think that nonlocal theory should not remain confined to a group of specialists and should instead spread among researchers interested in the modelling and numerical simulation of elasticity, viscoplasticity and damage processes.

As a conclusion, it is clear that Eringen's latest book is a fascinating and stimulating one that should have a dedicated place on the shelve of every researcher in physics, mechanics or materials science.

References

[1] R.D. Mindlin and N.N. Eshel. On first strain gradient theories in linear elasticity. Int. J. Solids Structures, 4:109–124, 1968.
[2] P. Germain. La méthode des puissances virtuelles en mécanique des milieux continus, première partie: théorie du second gradient. J. de Mécanique, 12:235–274, 1973.
[3] G. Pijaudier-Cabot and Bazant Z.P. Nonlocal damage theory. J. Engng Mech., 113:1512–1533, 1987.

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