November 2009

Instructions for Preparing Manuscripts for the *Journal of Research of the National Institute of Standards and Technology*

Manuscript Approval and Submission

- Your manuscript must first be approved by WERB, BERB, or JERB. If the title or author(s) are ever changed, please inform the proper review board.
- Gaithersburg authors submit manuscripts to the *Journal* by checking the appropriate box on form NIST-114. After WERB approval each such manuscript is automatically sent to the Chief Editor, who then contacts the author(s) to discuss the details of publication.
- Boulder authors submit manuscripts after receiving BERB or JERB approval by contacting the Chief Editor in order to discuss the details of publication.
- For manuscripts from either Gaithersburg or Boulder, the Chief Editor decides, in collaboration with the author(s), if additional review of an article is required.
- Manuscripts submitted to the *Journal* should not have been previously published in other journals or proceedings.

SI Units and Measurement Uncertainty

- Manuscripts must be consistent with the NIST policy on the use of the International System of Units (SI); see NIST Special Publication 811, 1995 Edition, Guide for the Use of the International System of Units (SI), by B. N. Taylor.
- Manuscripts must be consistent with the NIST policy on statements of uncertainty associated with measurement results; see NIST Technical Note 1297, 1994 Edition, Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results, by B. N. Taylor and C. E. Kuyatt.

Typing Instructions

- Enter ***all parts of the manuscript double-space*** in A4 or standard letter-size format, single column one side only; see attached guidelines entitled "Typefaces for Symbols in Scientific Manuscripts" and attached sample manuscript pages.
- Submit paper and electronic copies of the manuscript to the Chief Editor. The text of the electronic version may be in Microsoft Word®, WordPerfect®, TeX, or LaTeX and transmitted via email, diskette, CD, or zip disk; figures, if submitted electronically, should be in 300 dpi TIFF format (see more on figure requirements in the "Figures" section of these Instructions).

Disclaimer

- If it is necessary to refer to commercial products, include the following disclaimer once as a numbered ***footnot***e, not as a reference, at the first mention of such a product:

[1]Certain commercial equipment, instruments, or materials are identified in this paper to foster understanding. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

Organization of Article

- The components of the article and their sequence should be as follows:

Title
Author(s)
Affiliation
Abstract (about 200 words)
Key words (maximum 12, in alphabetical order, separated by semicolons)
Contents (if desired, unnumbered section; recommended only for lengthy articles)
Glossary (list of symbols, if desired, unnumbered section; recommended only for mathematically complex articles)
Body of text (with numbered sections; include tables in the text where first mentioned, each on a separate page)
Appendixes (if desired, numbered sections; e.g., 7. Appendix A, 8. Appendix B, etc.)
Acknowledgments (if desired, unnumbered section)
References (numbered section)
About the author(s)
Figure captions (typed double-spaced starting on a separate page) and figures

(over)

Headings and Subheadings

- Headings and subheadings in the text should have a ***maximum*** of four levels, separated from text, be left justified, and should be numbered as follows:

  1. (Main level)
  1.1 (Second level)
  1.1.1 (Third level)
  1.1.1.1 (Fourth level)

- When referring to numbered sections in the text use the form ". . . Sec. 1.1 . . . ," except at the beginning of a sentence where "Section 1.1 . . ." is the correct form.

Mathematical Expressions

- Center equations on the page with numbers in parentheses at the right margin. Each equation should be numbered consecutively with Arabic numerals starting with "1." (Identify any unusual symbols in the margin by a handwritten note.)

- Refer to equations in the text as Eq. (1), etc., except at the beginning of a sentence where "Equation (1)" should be used.

- Never hyphenate numbers with unit symbols even when used as adjectives (e.g., 0.25 cm thick plate is the correct form; 0.25-cm thick plate should not be used). If there is any ambiguity, rearrange the words accordingly. Thus the sentence "The samples were placed in 22 mL vials," might be written as "The samples were placed in vials of volume 22 mL."

References

- Indicate literature references in the text and in the list of references by numbers in brackets. Reference numbers should start with [1] and continue in order.

- When referring to references in the text parenthetically, use the form "[1]," for example, "As Jones and Smith have shown [1], . . ."; however, when a reference is referred to nonparenthetically, use the form ". . . Ref. [1] . . ." (except at the beginning of a sentence where "Reference [1] . . ." is the correct form), for example, "According to Ref. [1], ..."

- Reference citations should have the following format:

  Periodicals: [1] R. A. Perkins, H. M. Roder, and C. A. Nieto de Castro, A high-temperature transient hot-wire thermal conductivity apparatus for fluids, J. Res. Natl. Inst. Stand. Technol. **96** (3), 247–269 (1991).

  Books: [2] G. E. P. Box, W. G. Hunter, and J. S. Hunter, Statistics for Experimenters, John Wiley and Sons, Inc., New York (1978) p. 203.

  Proceedings: [3] B. Friedberg and R. W. Stark, Quantum interference study of magnetic breakdown and scattering lifetimes in magnesium, in Low Temperature Physics—LT 13, Vol. 4, Electronic Properties, Instrumentation, and Measurement, K. D. Timmerhaus, W. J. O'Sullivan, and E. F. Hammel, eds., Plenum Press, New York (1974) 177–184 (p. 182).

  Reports: [4] P. Woollard and V. M. Godley, The New Gravity System: Changes in International Gravity Base Values and Anomaly Values, HIG-80-1, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, HI, October 1980, 190 pp.

  Electronic documents: [5] Barry N. Taylor, Guide for the Use of the International System of Units, NIST Physics Laboratory, http://www.....(January 2002) [Accessed (date Accessed)].

- Authors are encouraged to recognize the useful information such complete citations provide readers. Nevertheless, if authors so choose, for periodicals and proceedings, the article title may be omitted and only the number of the first page of the article given (for periodicals, the issue number (in parentheses in the example) may also be omitted); and for reports, the number of pages may be omitted.

Footnotes

- Footnotes (double-spaced) should be brief and used minimally.
- Indicate footnotes by a superscript number starting with "1" and number them consecutively throughout the entire manuscript. Type footnotes at the bottom of the manuscript page on which they are referenced.

Tables

- Tables should appear in the manuscript on a separate page as soon as practicable after their mention in the text. (Follow the style of the table shown on p. 4 of the attached sample manuscript pages.)
- Each table should be numbered consecutively with Arabic numerals starting with "1" and have a concise heading and column headings. Only the first letter of the first word in both table headings and column headings is capitalized. Footnotes to entries in tables should be indicated by superscripts a, b, c, . . . , and typed at the bottom of the table. When referring to numbered tables in the text use the form ". . . Table 1 . . . ."

Figures

- Include figures at the end of the manuscript preceded with a list of figure captions typed (double-spaced) starting on a separate page. For printing purposes, figures submitted electronically should be in TIFF format with a resolution of at least 300 dpi; scannable (i.e., no shading, no fine lines) paper copies of figures are also acceptable. Figures, if submitted in color will appear in color on the Web version of the Journal, but will be printed in black and white. Note that figures in color may be reduced in quality when printed black and white. See examples of acceptable and unacceptable figures at the end of attached Sample Manuscipt Pages in these Instructions.
- Lettering and artwork should be neat and large differences in lettering size should be avoided. To test figure legibility, make a 77 mm wide copy (one *Journal* column width) using a reducing copying machine; if the reduced figure is still readable, its appearance in the *Journal* will be quite satisfactory. (Very complicated figures can be alloted more than one column width or up to 164 mm.)
- Identify each original with the figure number and author's name clearly written on the front of the figure in the lower right-hand corner.
- Figure captions should be as concise as possible—detailed descriptions of the figures should be given in the text. Keys to symbols such as □, Δ, +, ○ . . . should be made an integral part of the figure.
- Number figures with Arabic numerals, starting with "1" and continue in sequence throughout the text. When referring to numbered figures in the text use the form ". . . Fig. 1 . . . ," except at the beginning of a sentence where "Figure 1 . . ." is the correct form.
- Figures can be printed in color in the *Journal* under special circumstances. If your paper requires such figures, contact the Chief Editor during the course of manuscript preparation.

About the Authors

- Please include a one- or two-sentence section (double-spaced), immediately after the references, similar to the following example:

> ***About the authors:*** *Bruce F. Field is an electrical engineer in the Electricity Division of the NIST Electronics and Electrical Engineering Laboratory. Liu Ruimin is with the National Institute of Metrology, Beijing, China and was a Guest Researcher at NIST. The National Institute of Standards and Technology is an agency of the U.S. Department of Commerce.*

Proofreading

- Authors are responsible for correcting errors in typeset proofs. Changes in typeset proofs should be limited to those that make the typeset proofs conform with the original manuscript.

Sample Manuscript Pages and *Journal* Issues

- Sample manuscript pages are attached.
- Copies of the current issue of the *Journal* are available in Gaithersburg at the NIST Research Library Reference/ Information Desk and in Boulder at Publication Services, Room 1-4006, or the MASC Library. A copy of every issue is sent to each NIST Laboratory and Division Office as well.

These instructions are available on the Internet (*http://www.nist.gov/jres*). Double-click on "Instructions for preparing manuscripts."

Typefaces for Symbols in Scientific Manuscripts

Most word processing software now in use at NIST is capable of producing lightface (that is, regular) or boldface letters of the Latin or Greek alphabets in both roman (upright) and italic (sloping) types. The understandability of typed and typeset scientific and technical publications is facilitated if symbols are in the correct typeface. The following rules are taken from International Organization for Standardization (ISO) International Standard ISO 31-0:1992 to ISO 31-13:1992.

The typeface in which a symbol appears helps to define what the symbol represents. For example, irrespective of the typeface used in the surrounding text, "A" would be typed or typeset in

— italic type for the *scalar quantity* area: A;

— roman type for the *unit* ampere: A;

— italic boldface for the *vector quantity* vector potential: $\boldsymbol{A}$.

More specifically, the three major categories of symbols found in scientific and technical publications should be typed or typeset in either italic or roman type, as follows:

— symbols for *quantities* and *variables*: italic;

— symbols for *units*: roman;

— symbols for *descriptive terms*: roman.

These rules imply that a subscript or superscript on a quantity symbol is in roman type if it is descriptive (for example, if it is a number or represents the name of a person or a particle); but it is in italic type if it represents a quantity, or is a variable such as x in E_x or an index such as i in $\Sigma_i\, x_i$ that represents a number. An index that represents a number is also called a "running number." The following four sections give examples of the proper typefaces for these three major categories.

Quantities and variables — italic

Symbols for quantities are italic, as are symbols for functions in general, for example, $f(x)$:

$t = 3$ s	t time, s second	$T = 22$ K	T temperature, K kelvin
$r = 11$ cm	r radius, cm centimeter	$\lambda = 633$ nm	λ wavelength, nm nanometer

Constants are usually physical quantities and thus their symbols are italic; however, in general, symbols used as subscripts and superscripts are roman if descriptive:

N_{A}	Avogadro constant, A Avogadro	R	molar gas constant
θ_{D}	Debye temperature, D Debye	Z	atomic number
e	elementary charge	m_{e}	m mass, e electron

Running numbers and symbols for variables in mathematical equations are italic, as are symbols for parameters such as a and b that may be considered constant in a given context:

$$y = \sum_{i=1}^{m} x_i z_i \qquad\qquad x^2 = ay^2 + bz^2$$

Symbols for vectors are boldface italic, symbols for tensors are sans-serif bold italic, and symbols for matrices are boldface italic:

$\boldsymbol{A}\cdot\boldsymbol{B} = \boldsymbol{C}$ (vectors) $\qquad$ $\mathbf{\mathsf{T}}$ (tensors) $\qquad$ $\boldsymbol{A} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$ (matrices)

Symbols used as subscripts and superscripts are italic if they represent quantities or variables:

c_p p pressure $\qquad$ q_m m mass $\qquad$ σ_Ω Ω solid angle $\qquad$ ω_z z z coordinate

Units — roman

The symbols for units and SI prefixes are roman:

m	meter	g	gram	L	liter
cm	centimeter	μg	microgram	mL	milliliter

(over)

Descriptive terms — roman

Symbols representing purely descriptive terms (for example, the chemical elements) are roman, as are symbols representing mathematical constants that never change (for example, π) and symbols representing explicitly defined functions or well defined operators (for example, $\Gamma(x)$ or div):

Chemical elements:

Ar argon B boron C carbon

Mathematical constants, functions, and operators:

e	base of natural logarithms	Σx_i	Σ	sum of	$\ln x$	$\log_e$	natural logarithm of
$\exp x$	exp exponential of	$\sin x$	sin	sine of	$\lg x$	$\log_{10}$	common (decimal) logarithm of
$\mathrm{d}x/\mathrm{d}t$	d 1st derivative of	$\log_a x$	$\log_a$	logarithm to the base a of	$\mathrm{lb}\, x$	$\log_2$	binary logarithm of

Symbols used as subscripts and superscripts are roman if descriptive:

$\varepsilon_0^{(\mathrm{ir})}$ ir irrational E_k k kinetic

V_m^l m molar, l liquid phase μ_B B Bohr

Sample equations showing correct type

$$F = \frac{q_1\, q_2}{4\pi\, \varepsilon_0\, r^2} \qquad F = ma \qquad pV = nRT$$

$$\varphi_\mathrm{B} = x_\mathrm{B} V^*_{\mathrm{m,B}} / \Sigma x_\mathrm{A} V^*_{\mathrm{m,A}} \qquad E_\mathrm{a} = RT^2\, \mathrm{d}(\ln k)/\mathrm{d}T \qquad c_1 = \lambda^{-5}/[\exp(c_2/\lambda T) - 1]$$

$$E = mc^2 \qquad \tilde{p}_\mathrm{B} = \lambda_\mathrm{B} \lim_{p \to 0} (x_\mathrm{B}\, p / \lambda_\mathrm{B}) \qquad \frac{\boldsymbol{F}}{Q} = -\,\mathbf{grad}\; V$$

Greek alphabet in roman and italic type

The following table shows the proper form, in both roman and italic type, of the upper-case and lower-case letters of the Greek alphabet.

Greek alphabet in roman and italic type

alpha	A	α	A	α
beta	B	β	B	β
gamma	Γ	γ	Γ	γ
delta	Δ	δ	Δ	δ
epsilon	E	ε, ϵ	E	ε, ϵ
zeta	Z	ζ	Z	ζ
eta	H	η	H	η
theta	Θ, Θ[a]	θ, ϑ[b]	Θ, Θ[a]	θ, ϑ[b]
iota	I	ι	I	ι
kappa	K	κ, $\varkappa$[b]	K	κ, $\varkappa$[b]
lambda	Λ	λ	Λ	λ
mu	M	μ	M	μ
nu	N	ν	N	ν
xi	Ξ	ξ	Ξ	ξ
omicron	O	o	O	o
pi	Π	π, ϖ	Π	π, ϖ
rho	P	ρ, ϱ [b]	P	ρ, ϱ [b]
sigma	Σ	σ	Σ	σ
tau	T	τ	T	τ
upsilon	Υ	υ	Υ	υ
phi	Φ	φ, ϕ	Φ	φ, ϕ
chi	X	χ	X	χ
psi	Ψ	ψ	Ψ	ψ
omega	Ω	ω	Ω	ω

[a] The International Organization for Standardization (ISO) gives only the first of these two letters (see ISO International Standard ISO 31-0:1992).

[b] ISO gives these two letters in the reverse order (see ISO International Standard ISO 31-0:1992).

SAMPLE MANUSCRIPT PAGE

Transient Impact Response of Thick Circular Plates

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The finite element method was used to study the transient response of thick circular plates subjected to point impact. The response of plates having different geometries and subjected to impacts of different duration was studied in both the time and the frequency domains. It is shown that the transient plate response is composed of a number of different modes of vibration including P- and S-wave thickness modes, antisymmetric flexural modes, the rod mode, and P- and S-wave diameter modes. The origin of the diameter modes is discussed. Excellent agreement was found between the calculated frequency values and those obtained from finite element analyses.

Key words: finite element analysis; frequency spectrum analysis; Green's function; impact; stress wave propagation; transient plate response; vibration.

1. Introduction

This paper presents a finite element study of the transient response of unsupported, thick circular plates subjected to elastic point impact at the center of the top surface. Green's function solutions exist to determine the transient response of an infinite plate to a point force [1,2], and several...

The Green's function solution is the exact solution to the partial differential equations and associated boundary conditions governing elastic wave propagation. Green's function solutions can be obtained using Generalized Ray Theory.[1] The solution is in the form of an infinite series expansion....

An explicit, two-dimensional finite element code (DYNA2D) developed at Lawrence Livermore Laboratories for solving finite deformation, dynamic contact-impact problems [6,7] was used to perform the numerical analyses. The reader is referred to Refs. [8-10] for background infrmation on transient wave propagation in a plate subjected to point impact and on the use of the finite element method for studying the transient response of bounded solids.

2. Plate Response

The successful implementation of the impact-echo technique as a method for flaw detection in heterogeneous materials, such as concrete, requires an understanding of the reflection of transient stress waves by the free boundaries of a solid and....

The arrival of point 0′ (Fig. 5) is the result of a ray that travels back and forth along the top surface of the plate. The radiation patterns for the P and S waves show that both waves have zero amplitude in the normal direction at the surface, so the displacement caused by the arrival of point 0′ is significant. The arrival of point 2′ results from a ray that has been reflected through the thickness of the plate two times. When point 2′ is near the centerline of the plate, the corresponding ray path is as shown in Fig. 6. Similarly, the arrival of point 4′ results from a ray that has been

[1]Generalized Ray Theory was originally developed in the 1960s for geophysical applications, but is readily applicable to the study of transient waves in bounded solids. For an introduction to the ideas and formulation of ray theory, see Ref. [9].

reflected through the plate thickness four times. When point 4′ is near the centerline of the plate, the corresponding ray path is as shown in Fig. 7.

After points 2′ and 4′ arrive at the center of the plate, they travel toward the plate perimeter and subsequently return back to the center along the same ray paths that were shown in Figs. 6 and 7. For a point at or near the centerline of the plate, Eq. (1) can be used to calculate the frequency of successive

$$f_P = \frac{C_P}{[D^2 + (nT)^2]^{0.5}} ,$$

arrivals of points 2′ and 4′:

where D = diameter of plate,

T = thickness of plate,

C_P = P-wave speed,

n = number of the wavefront (2, 4, etc.).

The frequencies of successive P-wave arrivals of points 2' and 4' at a point on the surface of the 0.25 m thick, 1.6 m diameter plate are 2.4 kHz and 2.1 kHz, respectively. Peak 7 in Fig. 3(b) has a value of 1.7 kHz which is the….

2.1 Epicenter Response

2. 1.1 Green's Function Solution

Before considering the response of a plate to impact by a sphere, the impulse response is shown. In the impulse response, wave arrivals correspond to abrupt discontinuities in the waveform. It is therefore easier to determine the displacements caused by each individual wave arrival.

SAMPLE MANUSCRIPT PAGE −continued

(one side only for real manuscripts)

SAMPLE TABLE

(separate page for each for real manuscripts and to appear as soon as practicable after being mentioned in the text)

Table 1. Frequency values for flexural, rod, thickness, and diameter modes of three circular plates

			Flexural mode[a] (kHz)			Rod mode[b] (kHz)	Thickness mode (kHz)		Diameter mode ($n = 4$) (kHz)	
							P Wave	S Wave	P Wave	S Wave
D/T	D (m)	T (m)	1	2	3	4	5	6	7	8
6.4	1.6	0.25	3.5	12	20	10	8	4.9	2.1	0.65
5	1	0.2	7	22	36	15	10	6.1	3.3	0.95
4	2	0.5	4.3	10	16	7.5	4	2.4	1.7	0.43

[a] Approximate for $D/T = 4$ and 6.4 [4].

[b] Approximate [5].